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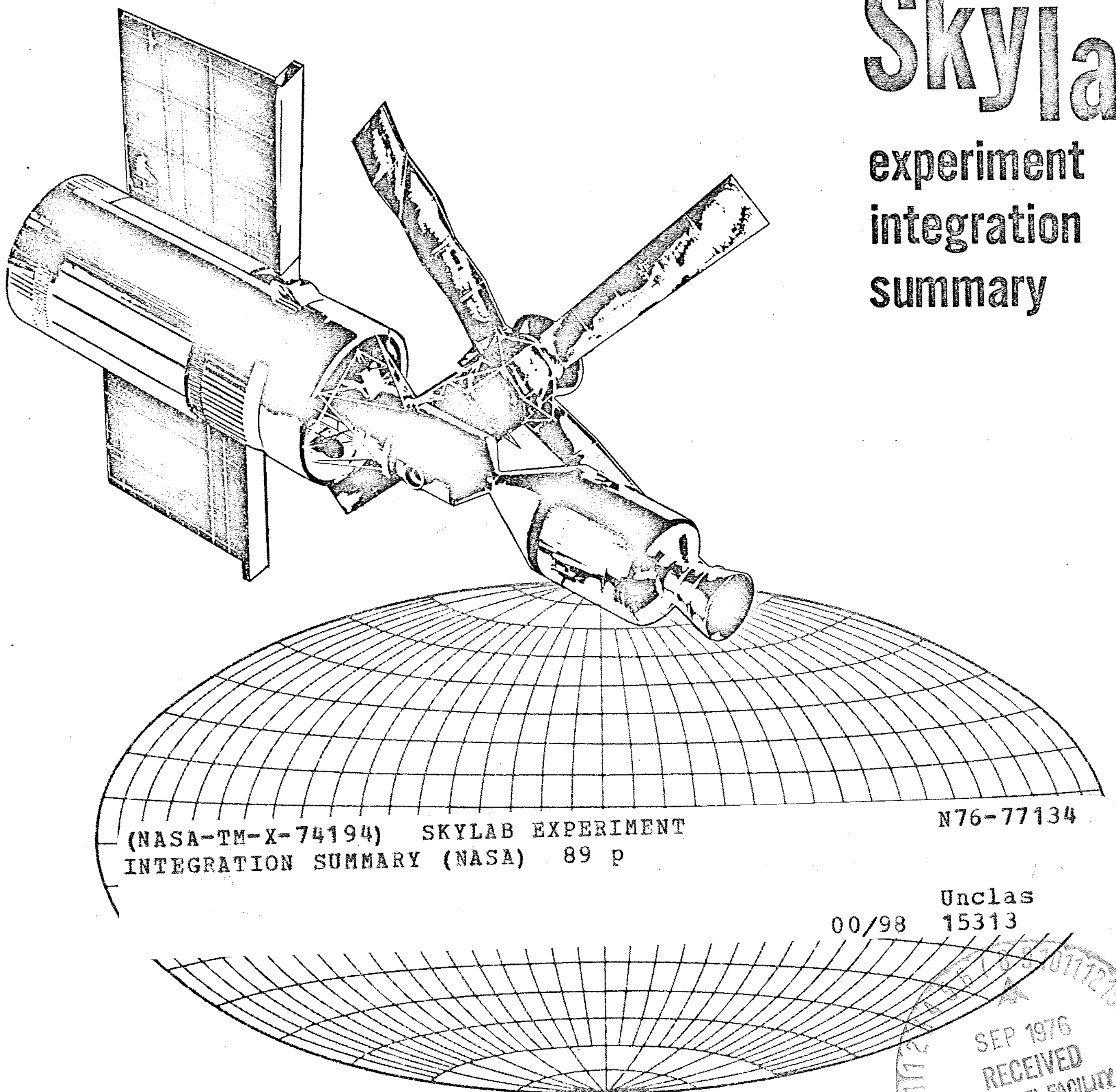
Skylab
experiment integration summary



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FOREWORD

The Skylab Experiment Integration Summary is published by the Marshall Space Flight Center of NASA to serve as a management summary source of reference data on the Skylab spacecraft and the experiments that are integrated with the hardware systems.

The Skylab is the first U.S. manned scientific space station and this document provides summary data on its major system capabilities and manned participation that have been incorporated to support the over 50 experiments that will be flown to conduct comprehensive scientific and operational investigations.

Use of this handbook will provide descriptive knowledge of the program, particularly the experiment sensors, instruments, and objectives and further the users' understanding of the capability and flexibility inherent in the Skylab spacecraft.

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Section 1
INTRODUCTION

Mercury, Gemini, and Apollo Missions were flown primarily to conduct basic space exploration and to substantiate the principle that man can survive and perform useful work in the space environment. In essence, both the missions and spacecraft formed the basis of operational experiments to advance man's knowledge of spaceflight. Skylab is a well equipped research facility in which unique experimental and operational tasks will be performed in near-Earth orbit.

Scheduled for launch in 1973, Skylab will be the United States' first manned space station. This vehicle is capable of prolonged manned missions and it possesses numerous support facilities to undertake an integrated and multidisciplined experiment program. Skylab is designed for an orbital life of 240 days during which time one crew will visit for a 28 day period and two crews for a duration of 56 days each.

The Skylab program objectives are to study the Earth, the Sun, man and space technology. These investigations range from synoptic surveys of selected areas of the Earth and solar disc observations to determinations of physiological adaptation to the space environment and space effects on materials and processes. The Skylab and its missions have been designed to support a broad spectrum of research and operational objectives and to maximize the benefits and flexibility of man's presence in conducting advanced research tasks.

The experiments selected to achieve the Skylab program objectives can be categorized broadly into six groups: (1) Earth resources, (2) solar observations, (3) scientific experiments, (4) life science investigations, (5) technology experiments, and (6) operations experiments. The experiments utilize unique opportunities available in Earth orbit which are not available for terrestrial investigations. For example:

- A site above the atmosphere where observations of astronomical objects can be made free from the effects of the atmosphere.

- A vantage point from which synoptic, repeated and periodic views can be made of the Sun, the celestial sphere and the terrain below the Skylab.

- A zero-gravity environment.

- A boundless vacuum environment.

The Skylab Student Project, which is a joint venture of the National Science Teachers Association and NASA, will also result in the conduct of experiments during the Skylab Missions. These experiments likewise will take advantage of the spectrum of Skylab's capabilities as a laboratory in Earth orbit.

Section 2
SKYLAB–VEHICLE AND MISSION

The Skylab is outfitted and provisioned including the installation of experimental apparatus on the ground and is launched unmanned as a single payload (Figure 2-1). Later, the Apollo Command and Service Module is launched with the three-man crew by a Saturn IB vehicle. The module then rendezvous and docks with the Skylab to complete the Skylab assembly and to initiate the manned mission phases.

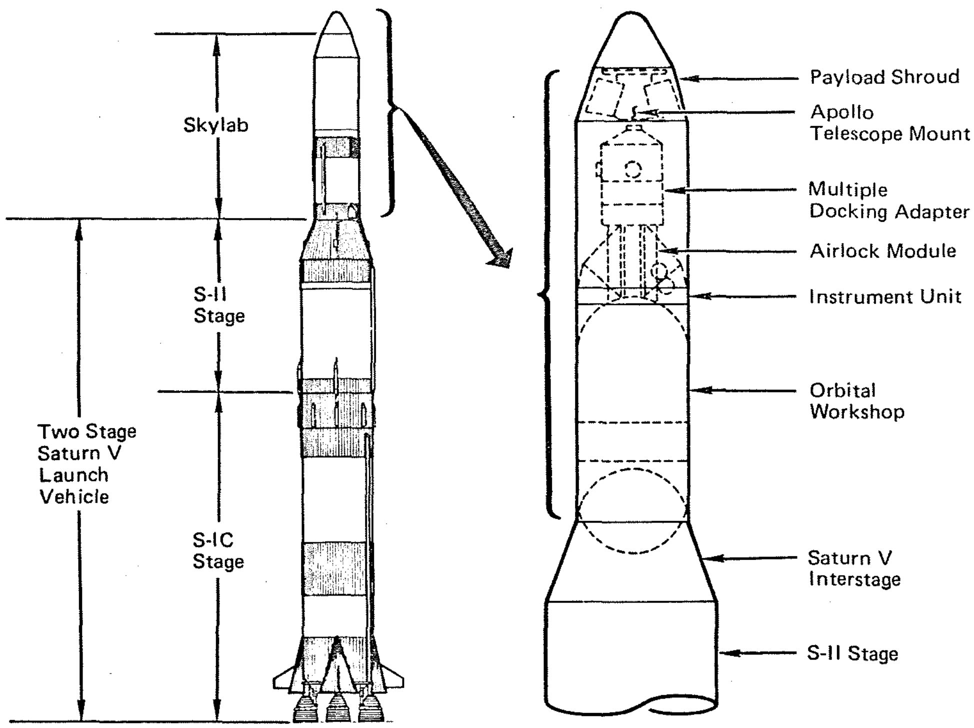


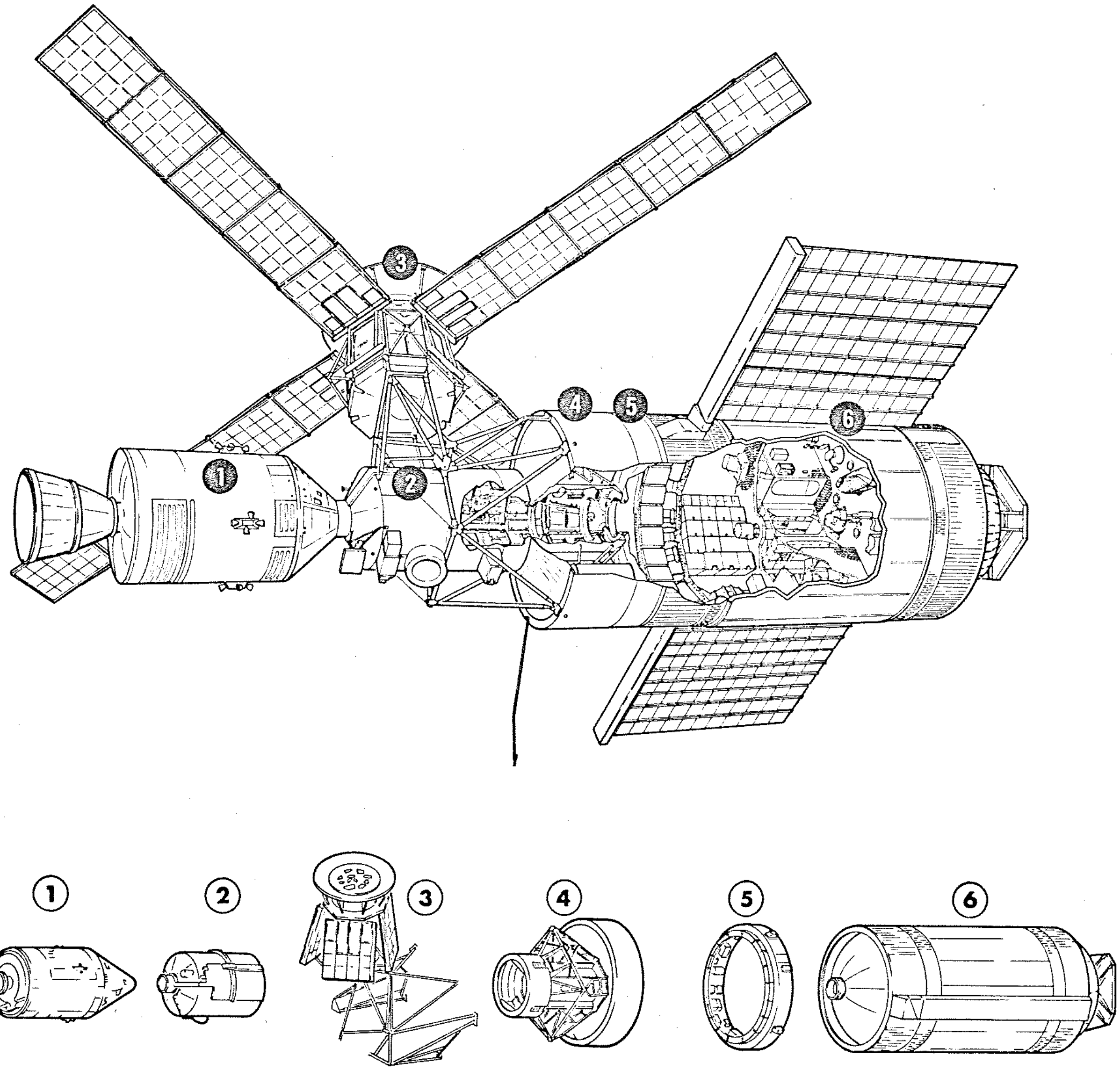
Figure 2-1. Skylab Launch Configuration

2.1 SKYLAB ORBITAL CONFIGURATION

The Skylab, with the Apollo Command and Service Module docked for manned operations, is illustrated in Figure 2-2. The Skylab consists of five major elements. These elements are: (1) a Multiple Docking Adapter, which provides the docking interface for the Command and Service Module and supports the majority of the Earth resources experiments; (2) an Airlock Module, providing an airlock to space and controls for operational systems; (3) an Apollo Telescope Mount, containing the United States' first manned telescope in space; (4) an Orbital Workshop, containing crew quarters and substantial experiment facilities; and (5) a Saturn-V Instrument Unit, used only during launch and initial deployment. Experimental equipments have been appropriately located in each of the Skylab modules based on environmental and operational requirements.

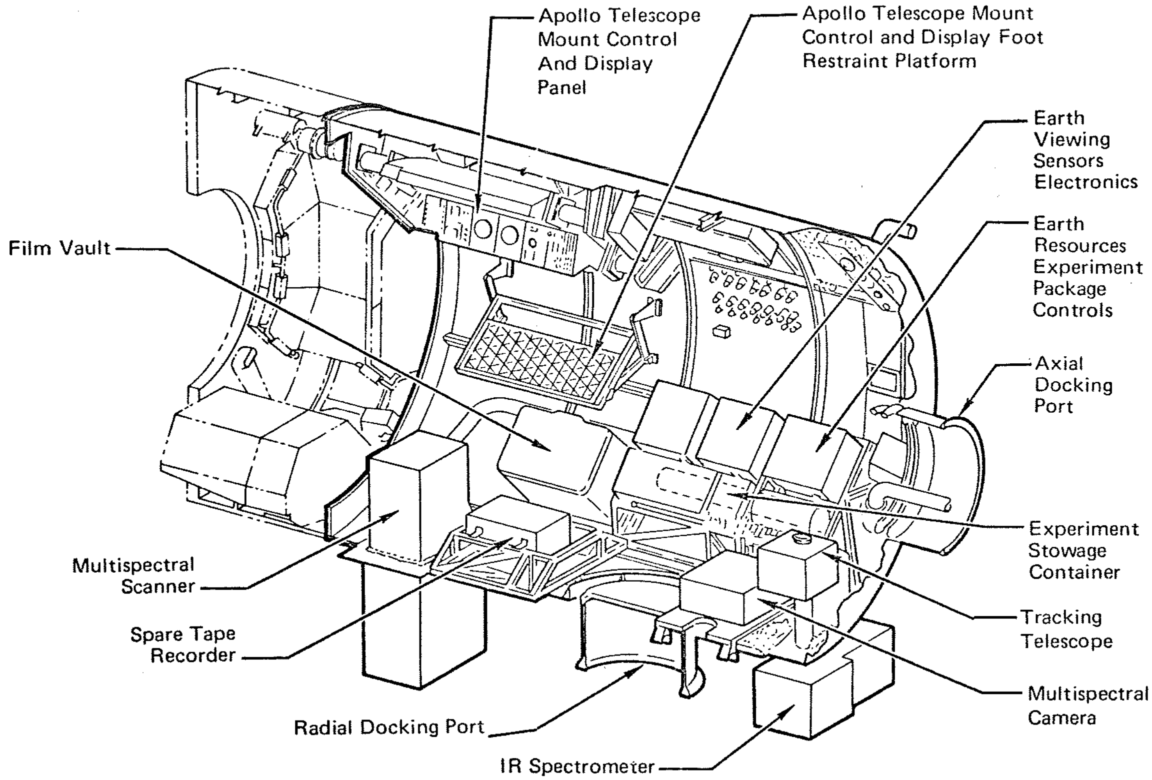
2.1.1 Multiple Docking Adapter

The Multiple Docking Adapter provides the docking interface for the Apollo Command and Service Module with the Skylab. It permits the transfer of personnel, equipment, atmosphere, power and electrical signals between the docked Command and Service Module and the Skylab. Two docking ports are located on the Multiple Docking Adapter (Figure 2-3). The axial port is



Element	Command and Service Module	Multiple Docking Adapter	Apollo Telescope Mount	Airlock Module/Fixed Airlock Shroud	Instrument Unit	Orbital Workshop
Function	Crew Ascent & Descent	Docking Interface ATM/EREP Controls & Displays	Solar Observation	Power Control & Distribution Environmental Control Utility Center Data System Extravehicular Activity Port	Launch Vehicle Control	Primary Living & Working Area Experiment Laboratory Stowage
Length (ft)	34.3	17.3	13.3	17.6	3.0	48.1
Diameter (ft)	13.0	10.0	–	10.0	21.5	21.6
Working Volume (cu ft)	366	1,140	–	613	–	9,550

Figure 2-2. Skylab Elements



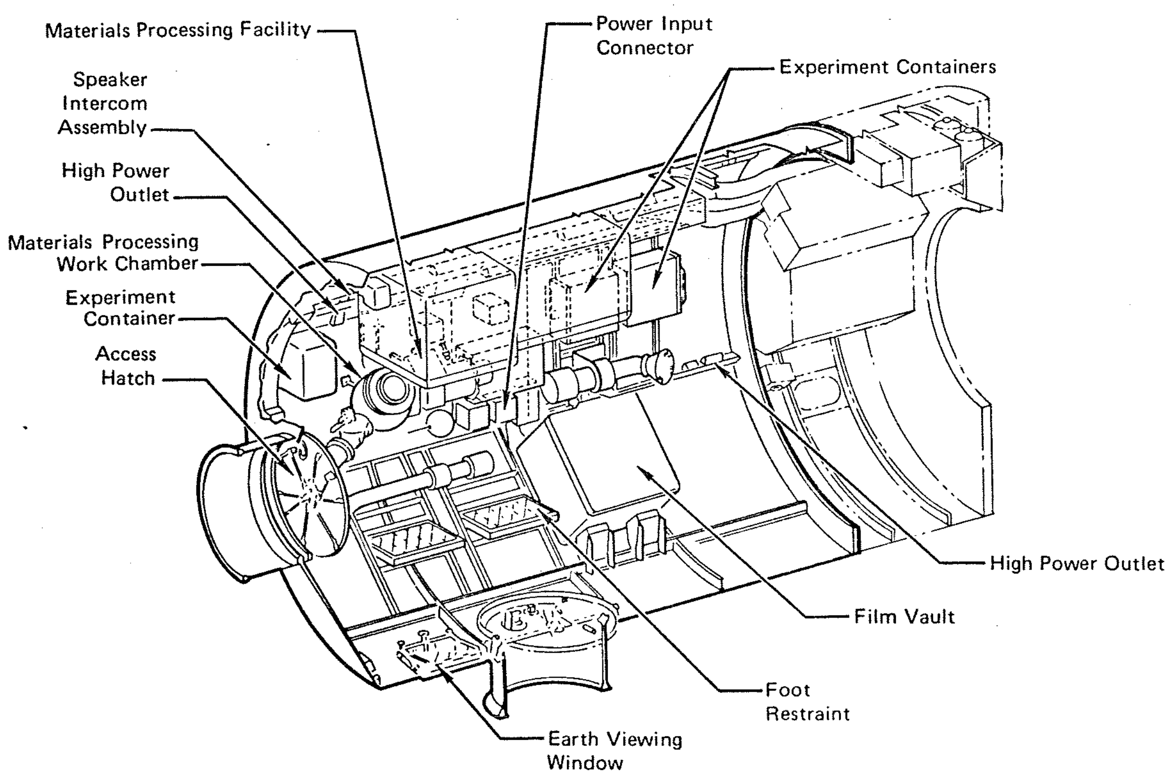


Figure 2-3. Multiple Docking Adapter

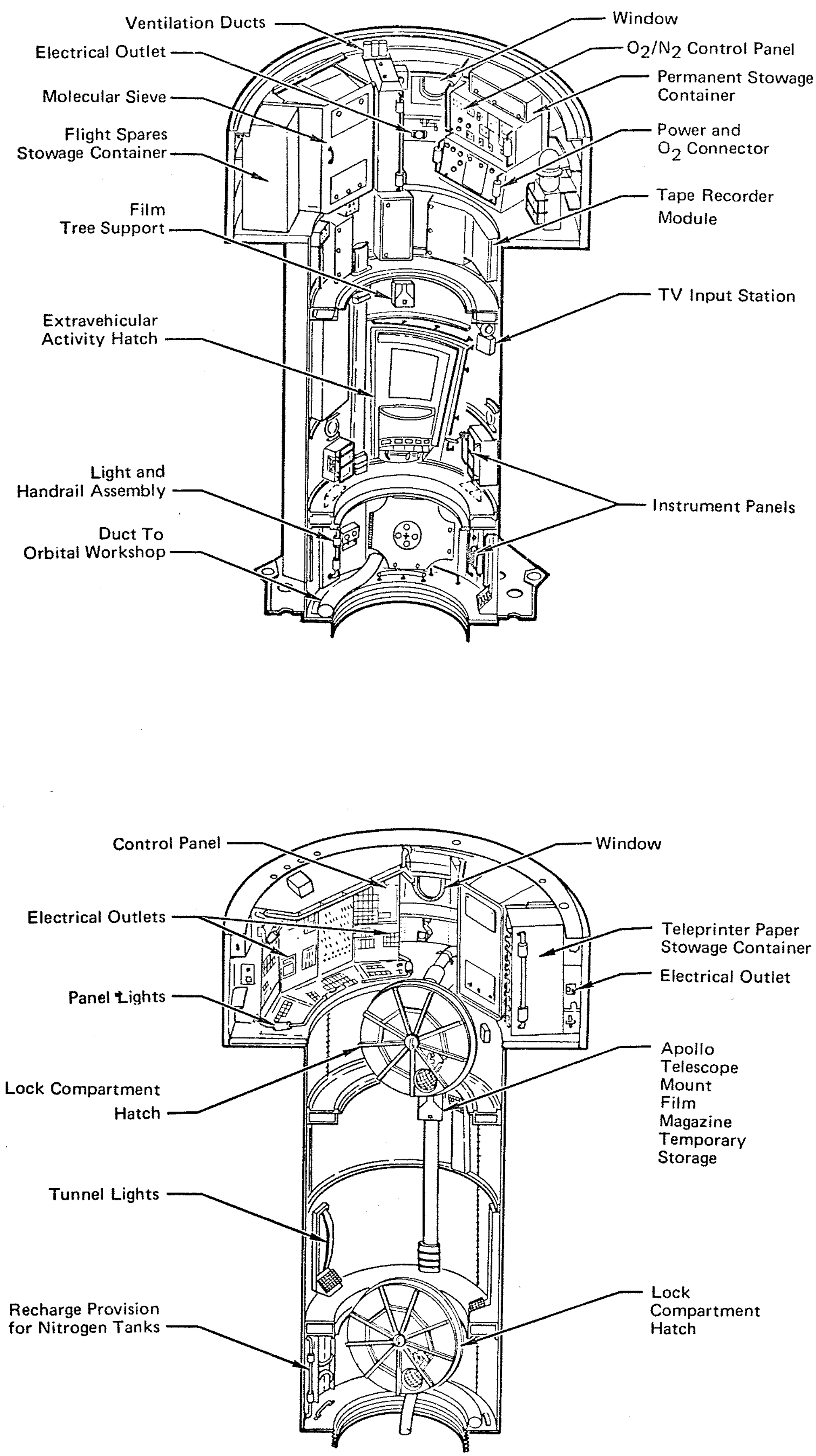


Figure 2-4. Airlock Module

equipped with complete support services for normal docking; the radial port, is provided for contingency only. The Multiple Docking Adapter contains control and display consoles for the Apollo Telescope Mount and the Earth Resources Experiment Package, and provisions for internal storage of hardware and experiments. Mounted externally are docking targets, running lights, and Earth viewing sensors.

2.1.2 Airlock Module

The Airlock Module, as the name implies, provides an airlock which allows the crew to perform extravehicular activities in space. The module also contains the control panels for electrical power distribution and controls for the atmosphere and thermal environment throughout the Skylab. The primary equipment for mission telecommunications, and data handling and recording are provided. The general arrangement of the Airlock Module, its components systems, and their relationship to the Skylab is shown in Figure 2-4.

2.1.3 Apollo Telescope Mount

The Apollo Telescope Mount is the United States' first manned solar observatory in space (Figure 2-5). It consists of an integrated set of eight telescopes to observe, monitor, and record the structure and behavior of the Sun and its corona. It includes guidance and navigation systems which provide attitude control and telescope alignment, and a solar array/battery system that supplies power to the Skylab.

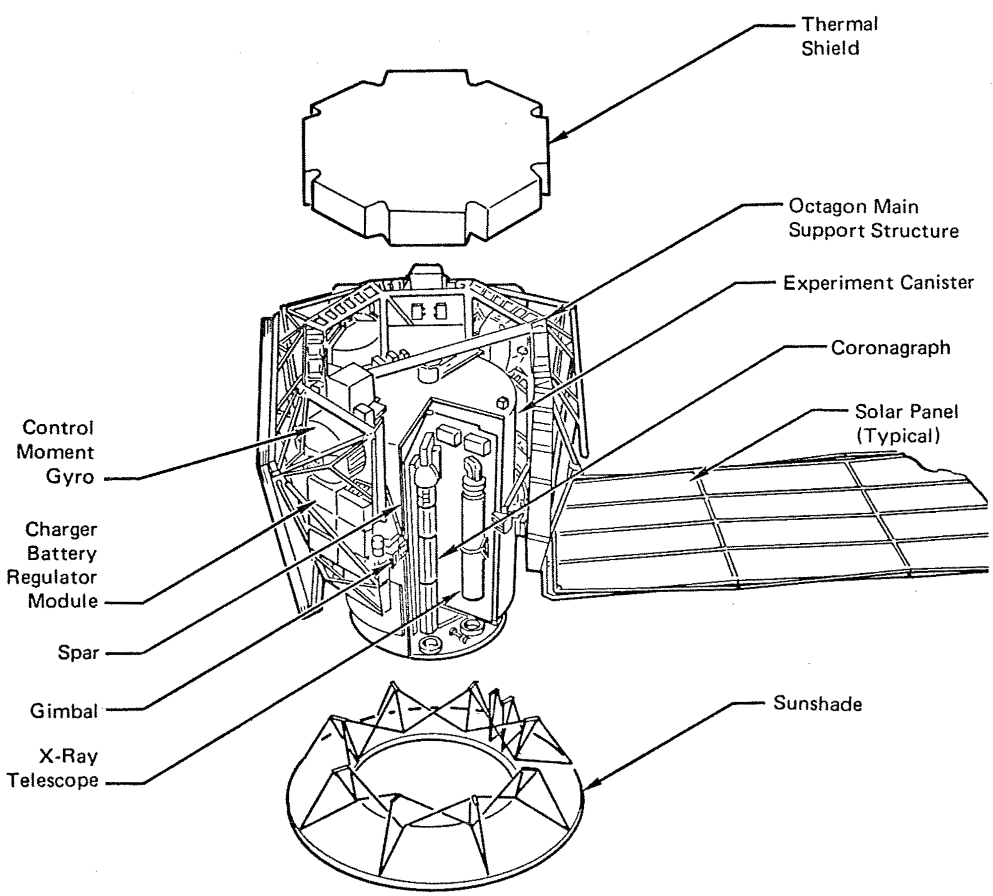


Figure 2-5. Apollo Telescope Mount Configuration

The control and display console for the Apollo Telescope Mount systems is located in the Multiple Docking Adapter (Figure 2-3). From this console (Figure 2-6) the crewman can control the Apollo Telescope Mount experiments and observe solar activity in real-time. The control and viewing systems permit the crewman to select areas of special interest on the solar disc and to point the telescopes rapidly to observe transient phenomena. Figure 2-7 depicts the installation of the telescopes on the optical bench spar.

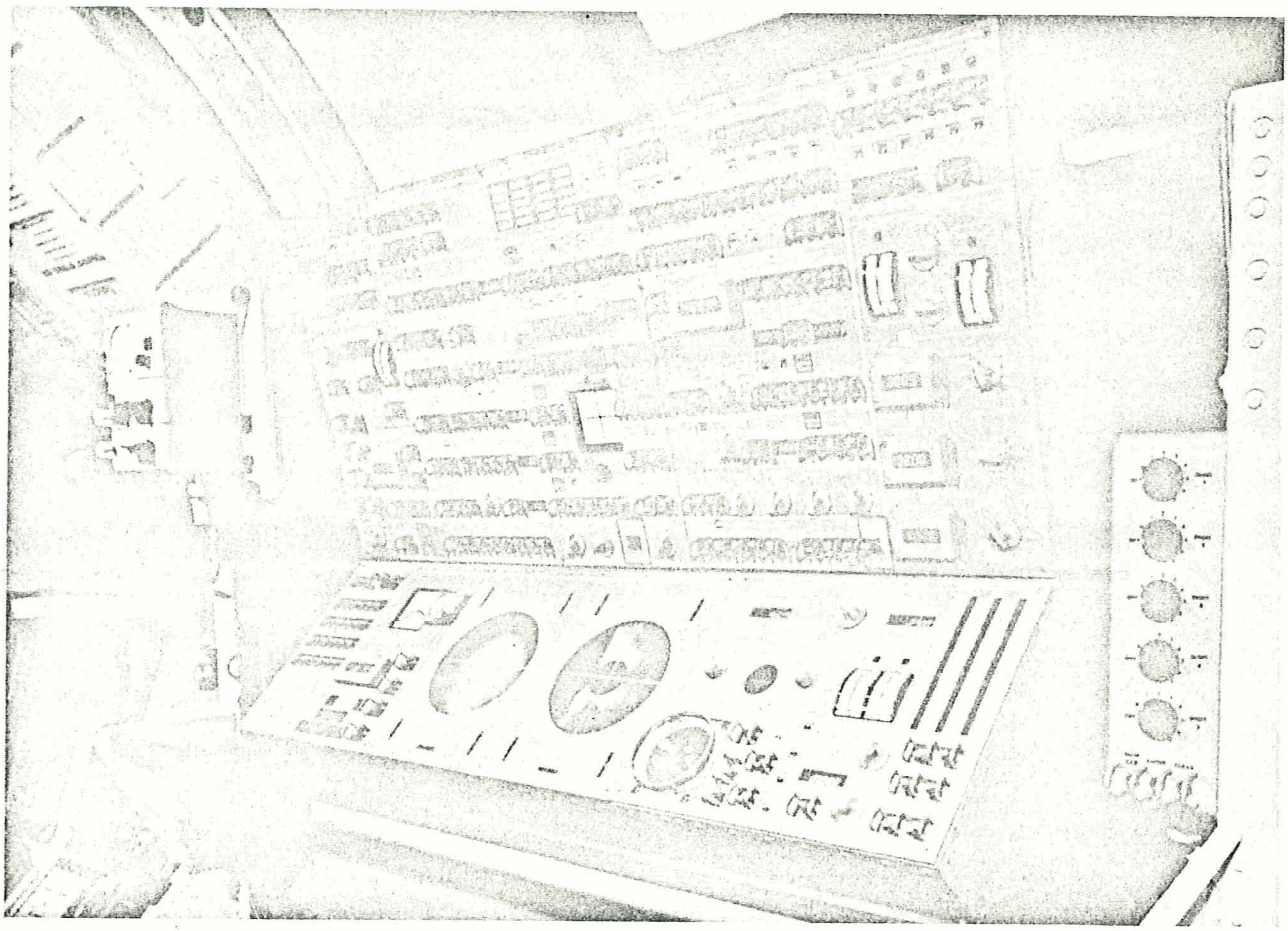


Figure 2-6. Apollo Telescope Mount Control and Display Panel

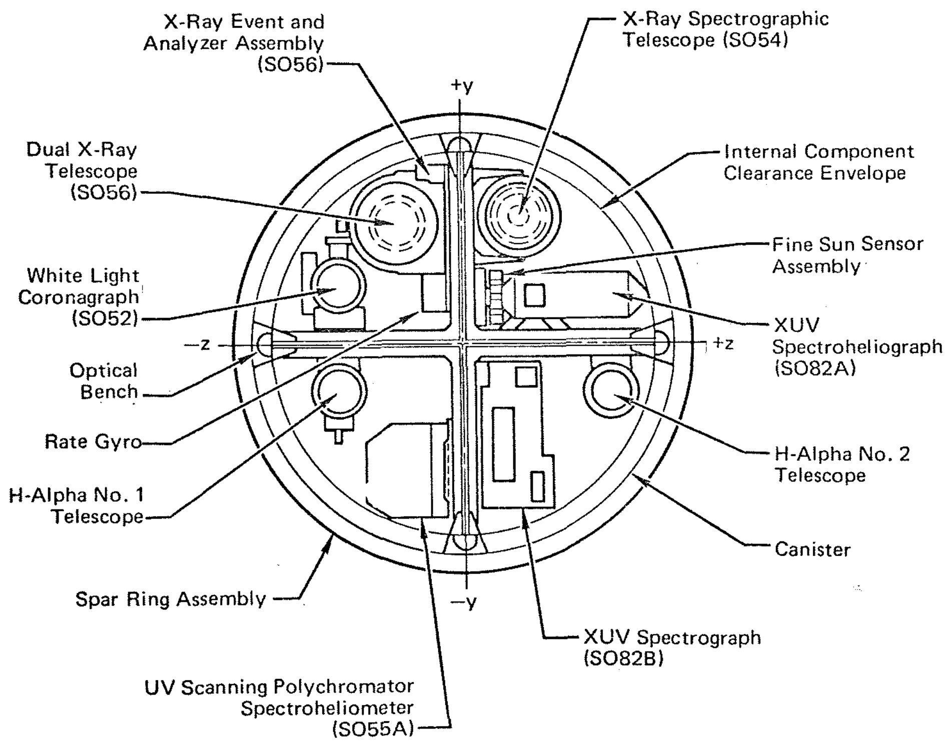


Figure 2-7. Telescope Installations

2.1.4 Orbital Workshop

The Orbital Workshop is a two-floor structure providing accommodations for the crew and a primary experiment area. The first floor is divided into four sections: the sleep compartment, the waste management compartment, the wardroom and the experiment work area. The biomedical experiments are performed in the experiment work area. The second floor is devoted primarily to experiments which require relatively large volumes or which utilize either of two scientific airlocks for external viewing or exposure. The remainder of the space is occupied by subsystems and storage compartments. These arrangements are shown in Figure 2-8.

The Workshop also is the storage area for crew supplies, such as food, water and clothing, as well as, providing for personal hygiene and waste and trash disposal.

2.1.5 Instrument Unit

The equipment and subsystems installed in the Instrument Unit, shown in Figure 2-9, are used only during launch and the first 7-1/2 hours of orbital operations. These subsystems provide launch vehicle guidance. Sequencing functions to deploy the Apollo Telescope Mount and its solar arrays, as well as the Workshop solar arrays, are also provided.

Experiments which can be mounted externally and do not require access by the crew can be installed in the Instrument Unit.

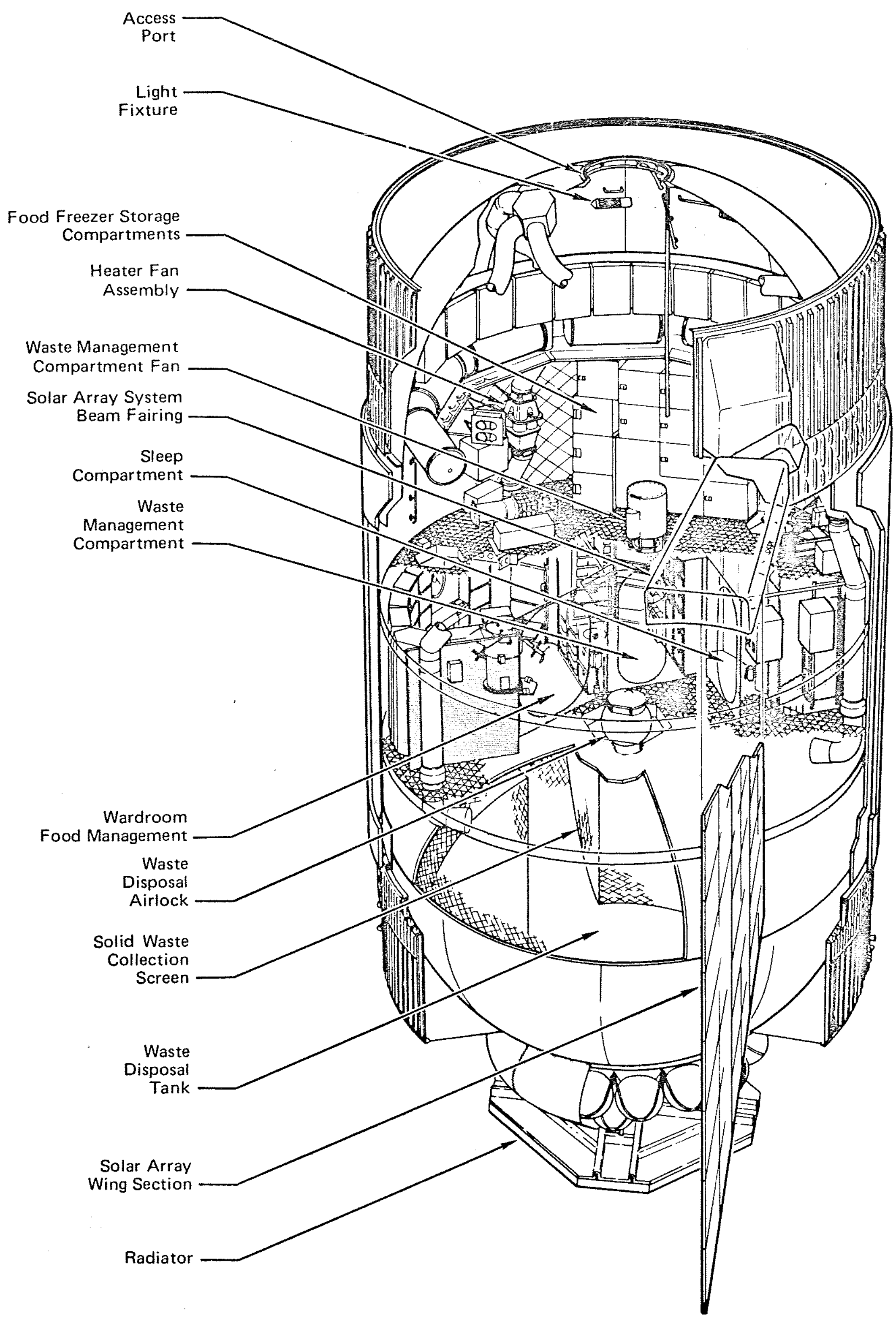


Figure 2-8. Orbital Workshop (Sheet 1 of 2)

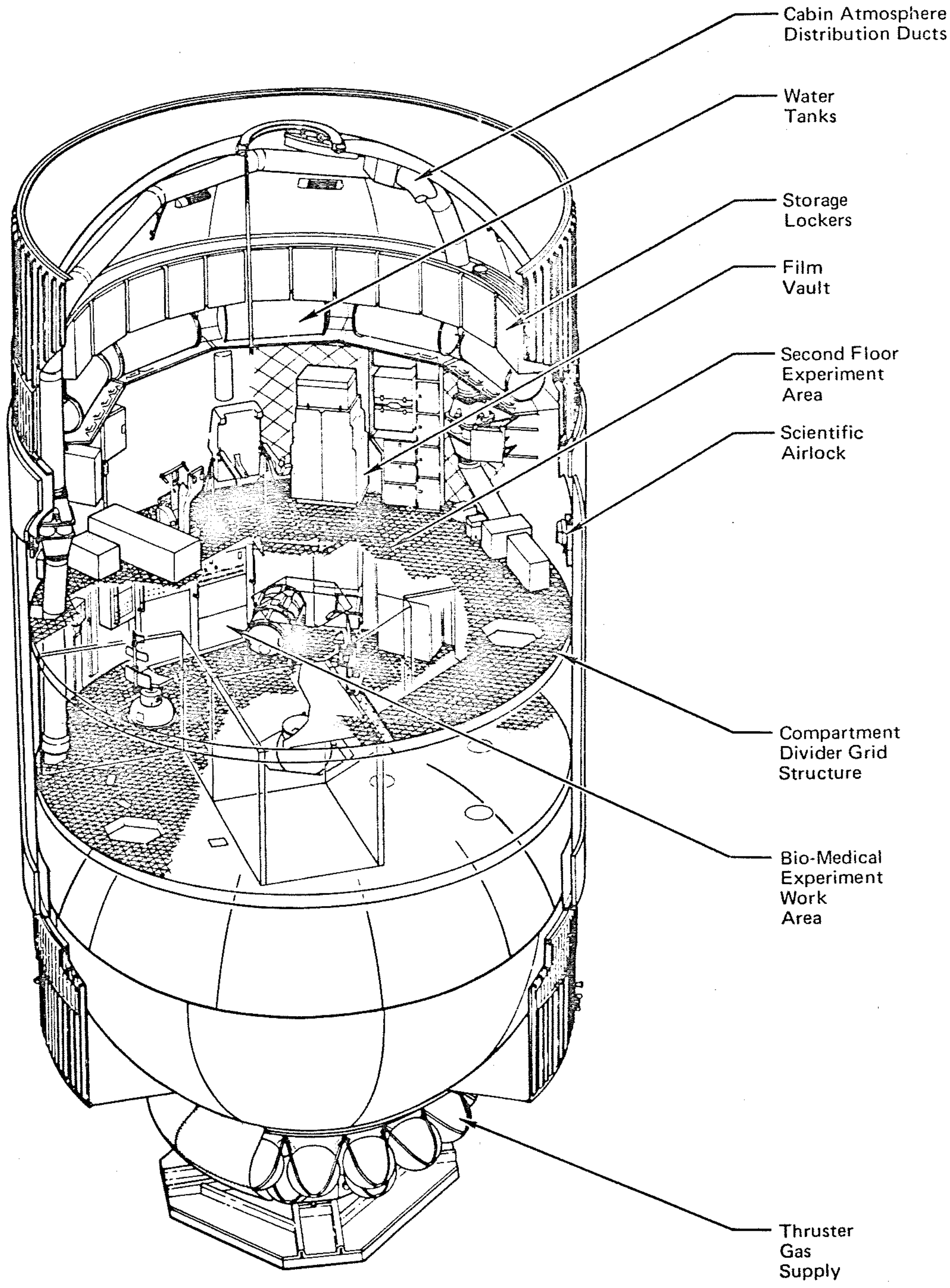


Figure 2-8. Orbital Workshop (Sheet 2 of 2)

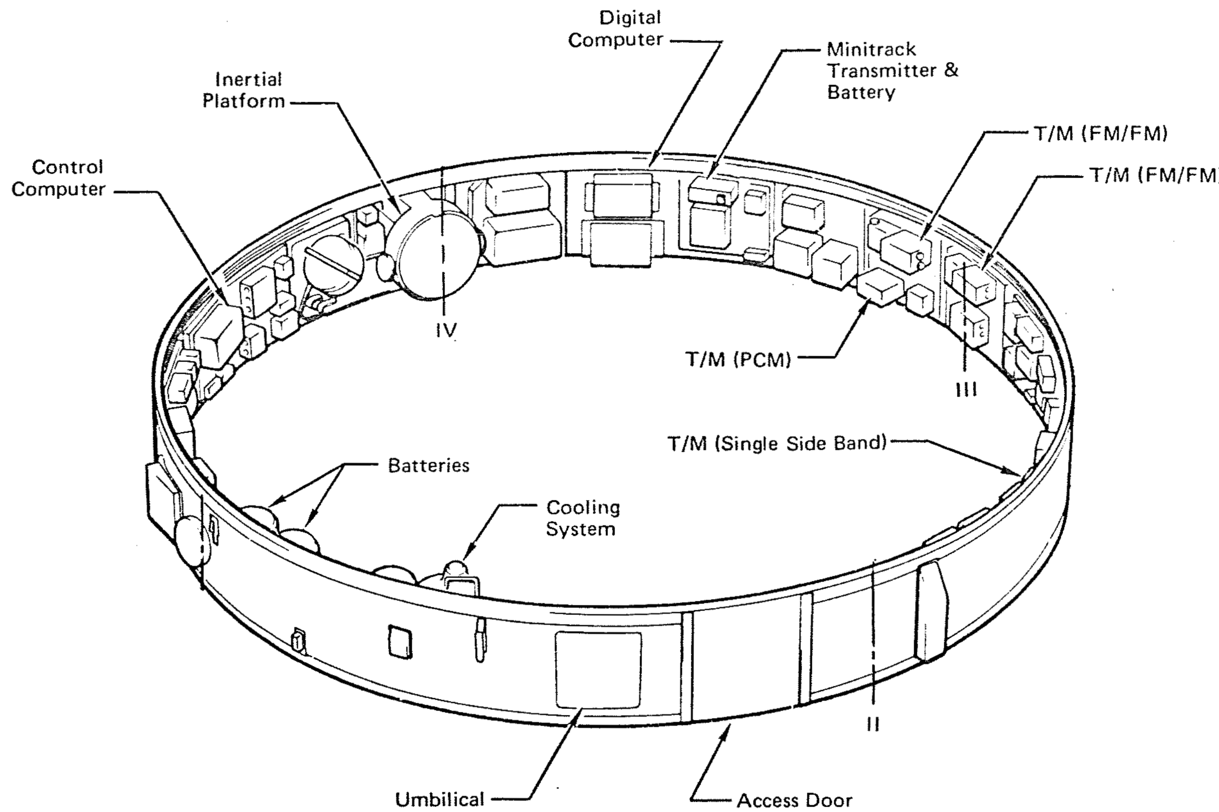


Figure 2-9. Instrument Unit

2.1.6 Apollo Command and Service Module

The Apollo Command and Service Module (Figure 2-10), modified for an orbital life of 56 days, serves as the manned logistics vehicle for the Skylab. When docked to the Skylab, the Command and Service Module except for communications equipment is powered down to a quiescent mode until required for return. The Command Module also provides for the stowage, resupply, and return of experiments and/or experiment data.

2.2 SKYLAB MISSION PROFILE AND OPERATIONS

The Skylab is launched by a single two-stage Saturn V. Three separate Saturn IB's launch the Command and Service Modules (Figure 2-11). The initial mission consists of two launches approximately one day apart. The first launch from Kennedy Space Center is the Skylab. Following insertion into an orbit of approximately 235 nmi altitude at an inclination of 50 degrees, the S-II stage is separated by retrorockets and the Skylab is rotated by the attitude control system to allow jettisoning the Payload Shroud. The Shroud provides environmental protection for the payload and supports the Apollo Telescope Mount during launch. The attitude control system begins to orient the Skylab to a solar-inertial attitude. The Apollo Telescope Mount is deployed. At this point in the activation sequence, the Apollo Telescope Mount and Workshop solar arrays are deployed to assure the availability of electrical power.

Before launching the first Command and Service Module, the Skylab is checked by ground command and telemetry data for operational conditions prior to the manned launch. The manned Command and Service Module will

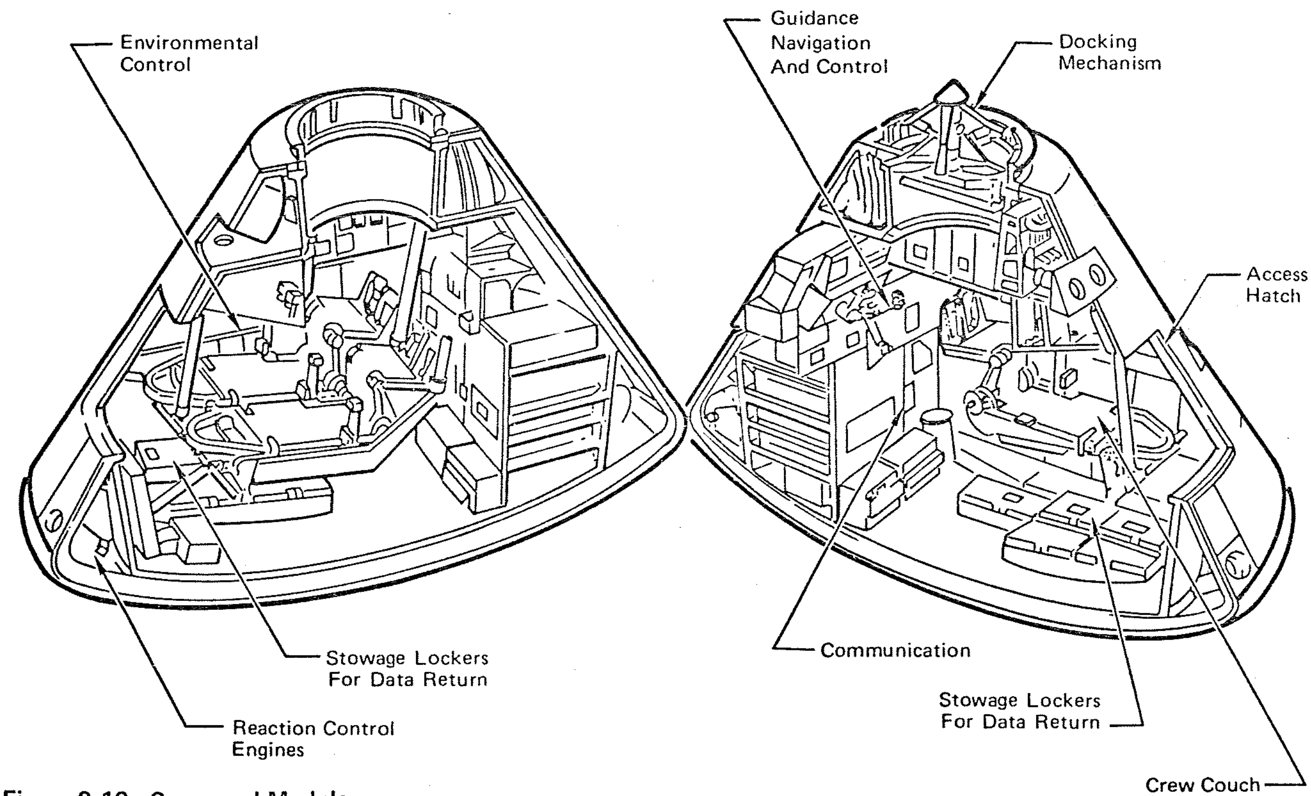


Figure 2-10. Command Module

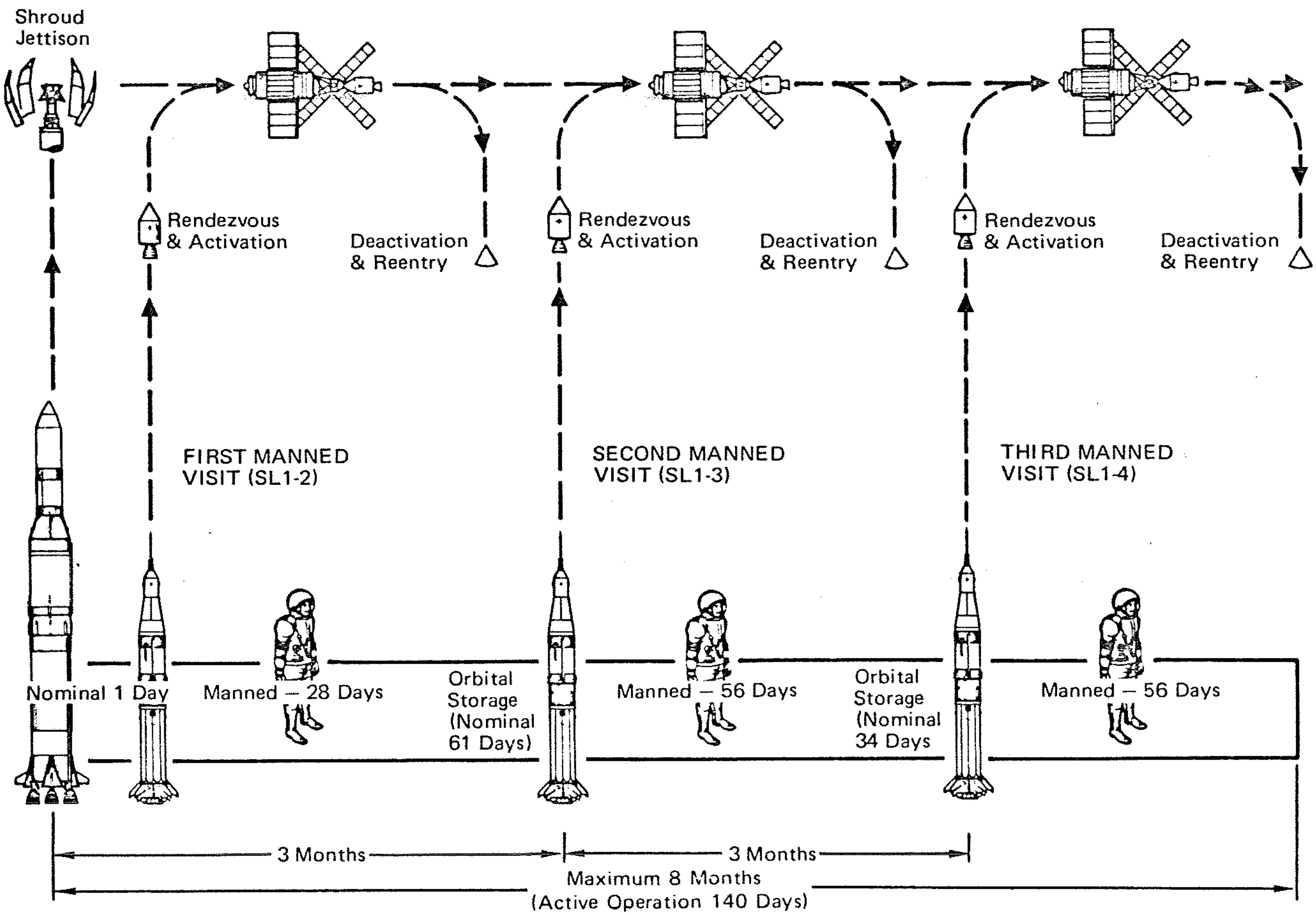


Figure 2-11. Skylab Mission Profile

be launched by a Saturn IB vehicle and inserted into an 81 to 120 nmi phasing orbit. The Service Module propulsion and reaction control systems are then used to perform orbital transfer and rendezvous maneuvers to dock with the Skylab. The crew transfers to and activates the Skylab.

The first manned mission includes a series of medical experiments for the evaluation of astronaut activity and physical condition during the conduct of the experiments. Experiment tasks include solar astronomy, Earth resources, and technical experiments. The 28 day mission will begin with the launch of the Command and Service Module. At completion of the scheduled mission, the Skylab will be prepared for the unmanned orbital phase and the Command and Service Module will undock from the Skylab and deorbit. Depending upon mission duration, recovery will occur in daylight in either the West-Atlantic or the Mid-Pacific recovery area. During the unmanned phase, the Skylab will be in a semiactive condition and will remain in the solar-inertial attitude.

The second manned Command and Service Module mission is launched approximately 90 days after the first manned launch. This mission will be for a duration of 56 days from launch. The mission purpose is to resupply selected items, continue specific experiments, and initiate new experiments. The third manned Command and Service Module mission will be launched 90 days after the second Command and Service Module launch. This mission is also planned for 56 days. It too will provide selected resupplies and the crew will complete the technical and scientific experiments. A set of replica vehicle and experiment hardware will be available at the launch site to ensure a backup for each mission segment.

After completion of the experiment and mission activities, the Skylab will be prepared for final orbital storage in the solar-inertial attitude. The Command and Service Module will undock from the Skylab and return to Earth. In total, the Skylab represents an opportunity to captalize on 420 man-days of orbital experiment activities within an eight-month total mission duration.

The Skylab facility represents orbital resources with which experimental activities can be supported. These resources can be categorized into three main classes: (1) manpower in terms of crew availability to conduct experiments, (2) time in terms of Skylab viewing characteristics to conduct remote sensing experiments, and (3) physical resources such as structural elements, power, data retrieval, environmental control, and miscellaneous items of equipment and supplies.

3.1 CREW OPERATIONS

Crew time for experiments is a prime resource in the Skylab experimental program. Utilization of available crew time and skills must be optimized by effective scheduling of crew activities. Figure 3-1 indicates the crew involvement in conducting experiments for a typical mission day.

Legend:

A = Personal Hygiene
B = Eating & Food Management
C = System Housekeeping
D = Rest & Relaxation (off duty)
E = Experiment Mode A
F = Experiment Mode B
G = Observer
H = Test Subject
I = Mission Planning
J = Sleep

Experiments:

K = Mineral Balance
L = Nuclear Emulsion
M = Zero Gravity Single Human Cells
N = Apollo Telescope Mount
O = Lower Body Negative Pressure Device
P = Human Vestibular Function
Q = Vectorcardiogram
R = Metabolic Activity

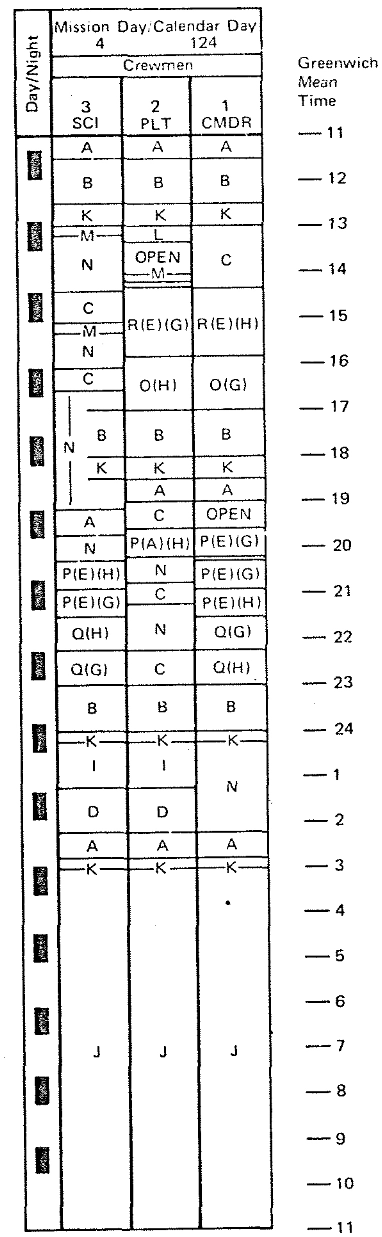


Figure 3-1. Assigned Crew Activities During Typical Mission Day

A most important factor in assuring experiment flexibility and success is a versatile crew possessing complementary skills. The flight plan shows requirements for 21 experiments which require the participation of more than one crewman. It is evident, considering the variety of the experiments, that each crewman must be versed in several skills. However, in the selection and training of the Skylab crews, one crewman is an expert in a given major discipline. He is assigned the primary in-flight responsibility with preflight training emphasis on a particular set of experiments. The other crewmen are given similar responsibilities and training so that the crew can carry out all the experiments for a particular mission.

Since the experiment emphasis differs for each mission, the type of training and delegation of responsibilities will vary from crew to crew. The crews will have prior experience in various disciplines as reflected by the experiments to be conducted. The general division of responsibilities for the Skylab crew is as follows:

A. **Crewman No. 1**, the Commander, is responsible for launch, rendezvous, docking, undocking, and reentry operations. He is in command of the overall mission.

B. **Crewman No. 2**, the Pilot, in addition to his experiment responsibilities, is also responsible for monitoring and maintaining the Command and Service Module systems during orbital operations.

C. **Crewman No. 3**, the Science Pilot, as his title implies, will be responsible for the scientific aspects of the mission.

Crew cross-training requirements are implied in the division of responsibilities. Cross-training considerations necessary to support the Skylab mission are:

A. All crewmen are subjects and have an understanding of the medical experiments. Also, a qualified observer must act as the experiment conductor when the medical astronaut is used as the test subject. This requires extensive cross-training in the medical area.

B. All three crewmen are trained and capable of operating the Apollo Telescope Mount, monitoring the solar disc for signs of activity, and activating the cameras to record solar events.

C. Earth resources experiments require two men to operate the equipment. In addition, reorientation in Skylab attitude from solar inertial to Earth-pointing requires the coordinated efforts of the entire crew.

D. Corollary experiments which support scientific and technological objectives likewise require the services of the crew. Understanding of the experiment objectives and the apparatus characteristics involved will enhance the degree of success achieved for each experiment.

The Skylab first crew experiment responsibility assignment schedule is indicated in Table 3-1.

Table 3-1. Skylab Experiment Responsibility Assignment (SL 1-2)

Crewman	Activity Schedule
Commander	Earth resources experiment package control and display panel operation, maneuvering equipment evaluations, retrieval of thermal control coating samples, radiation monitoring in spacecraft, biological assessment of circadian rhythm experiment, and conduct of zero gravity effects on human cells.
Pilot	Operation of infrared spectrometer tracking telescope, manual navigation sightings, monitoring of spacecraft aerosol environment, measurement of crew induced vehicle disturbances, materials and processes investigations, habitability and crew quarter assessment, earth resources experiment package sensor maintenance, stellar astronomy experiments, Skylab contamination experiments.
Science Pilot	Maintenance of medical and life support systems, photography of horizon ultraviolet airglow, evaluation of human vestibular function, sleep monitoring, calibration of specimen and body mass measuring devices, conduct of time and motion studies, and maintenance of Apollo telescope mount control and display panel and equipment.

3.2 VIEWING CHARACTERISTICS

The remote sensing experiments require three basic viewing fields: solar, Earth, and celestial space. Fulfillment of these viewing requirements is provided by compatible location of the affected experiments within the Skylab orbital configuration and by the Skylab attitude. Attitudes that provide these viewing requirements are solar orientation and local vertical Earth pointing.

The solar inertial attitude, depicted in Figure 3-2, holds the principal X-axis of the Skylab in or near the orbital plane, and the Z-axis oriented toward the Sun parallel with the Earth-Sun line. This solar inertial attitude is dictated by the Skylab and Apollo Telescope Mount solar arrays. Further pointing accuracy is achieved for those experiments contained within the Apollo Telescope Mount as shown in Table 3-2. Manual course pointing of the Apollo Telescope Mount is also available.

Table 3-2 Apollo Telescope Mount Pointing Accuracy

System Axis	Accuracy	Stability
X	±2.5 Arc Sec	±2.5 Arc Sec/15 Min
Y	±2.5 Arc Sec	±2.5 Arc Sec/15 Min
Z	±10 Arc Min	±7.5 Arc Min/15 Min

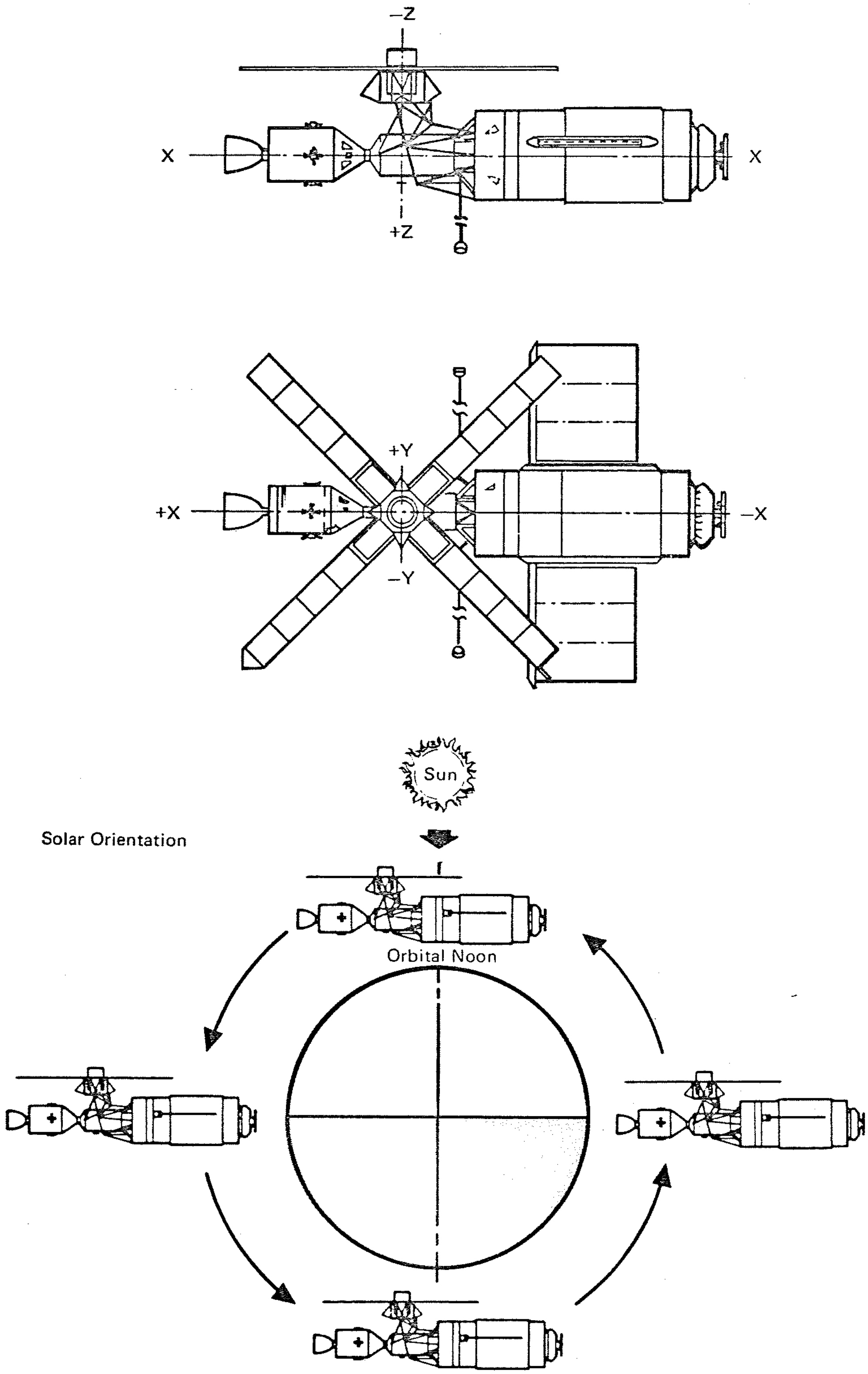


Figure 3-2. Skylab Solar Inertial Attitude

The local vertical orientation is when the +Z-axis of the Skylab is aligned with a continuously varying local vertical. Figure 3-3 is typical of a 120-degree maneuver centered around the Earth-Sun axis (orbital noon).

However, the local vertical orientation can be made for other durations and elsewhere in the orbit. The accuracy to which the Skylab can be held in attitude is shown in Table 3-3.

Table 3-3. Skylab Orbital Configuration Pointing Accuracy

System Axis	Solar Inertial (with solar reference)	Local Vertical Earth Oriented	Local Vertical Rendezvous
X	±6 Arc Min	±2 Deg	±6 Deg
Y	±6 Arc Min	±2 Deg	±12 Deg
Z	±10 Arc Min	±2 Deg	±6 Deg

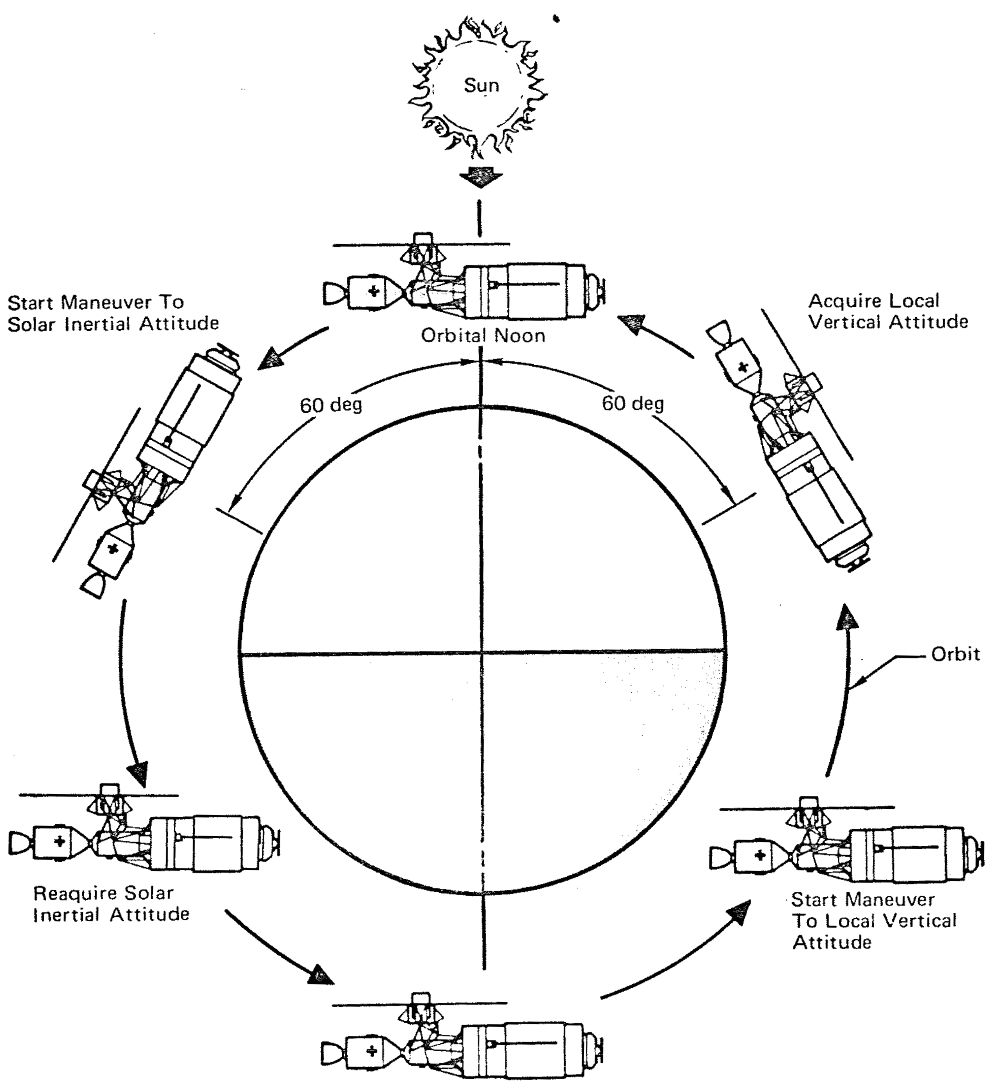


Figure 3-3. Skylab Local Vertical Orientation (Orbital Noon Case – 120 degrees pass)

Earth viewing criteria of concern to a potential user are latitude coverage, look angle (which is the angle between the nadir and a vector to the target), observation frequency and duration, solar illumination angle and ground area coverage. The Skylab ground trace (Figure 3-4) partially indicates the capability in meeting the Earth viewing experiments latitude coverage, observation frequency, and duration requirements. The latitude coverage is indicative of the 50-degree orbit inclination, and since the orbit is subsynchronous, the ground trace repeats itself every five days (76 orbits).

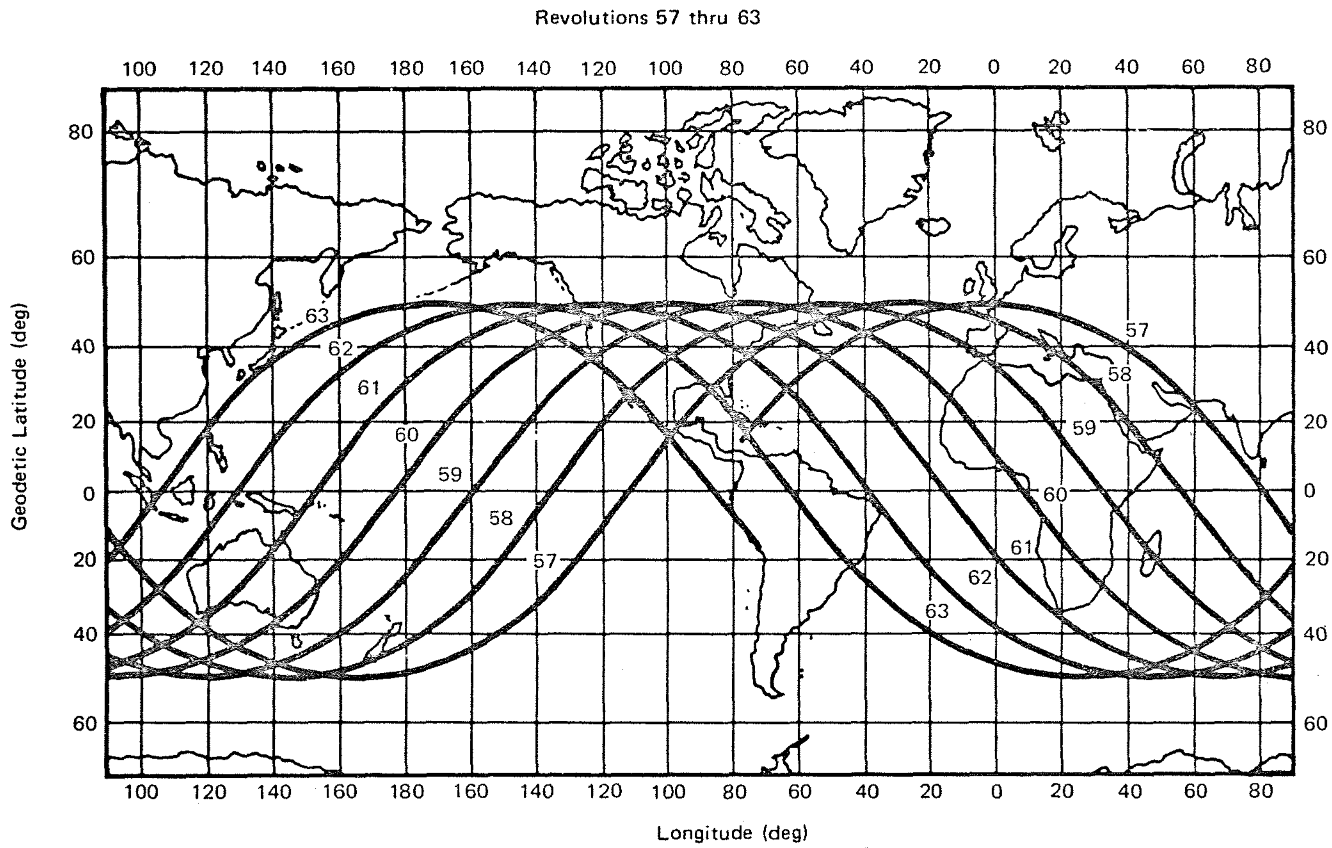


Figure 3-4. Skylab Ground Trace

Figure 3-5 depicts the daily variations in look angle for a given target. When ground illumination is also a consideration, Figure 3-6 provides data which define the maximum Sun angle attained on the ground track below the Skylab as a function of latitude and solar declination. These maximum

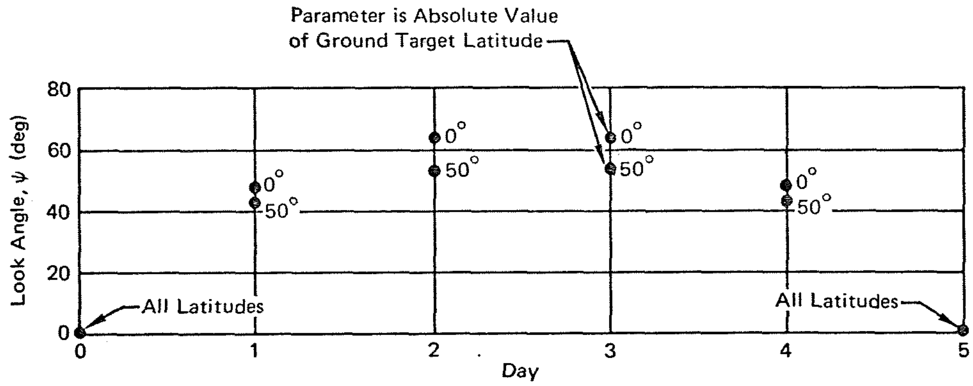


Figure 3-5. Daily Look-Angle Over Target Latitude

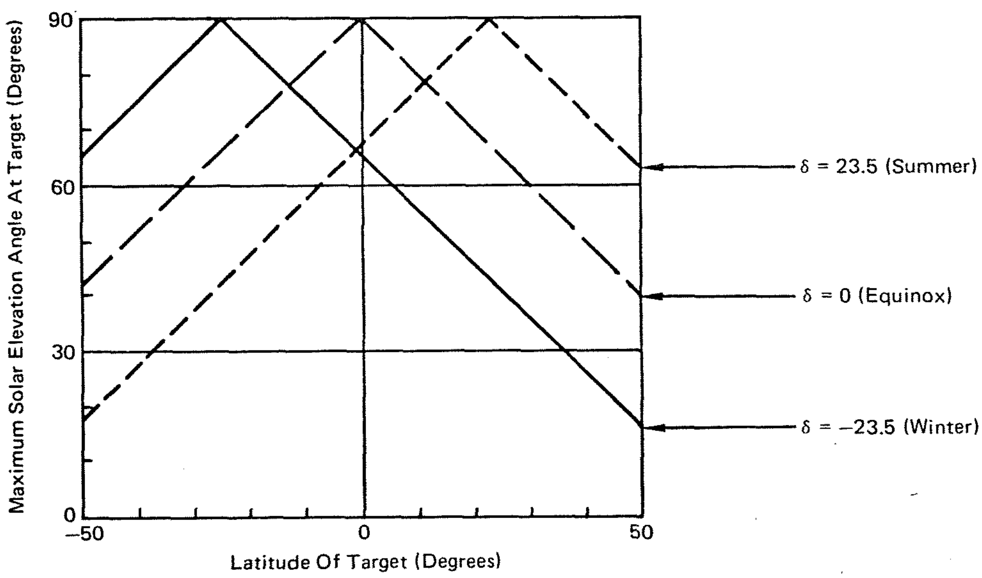
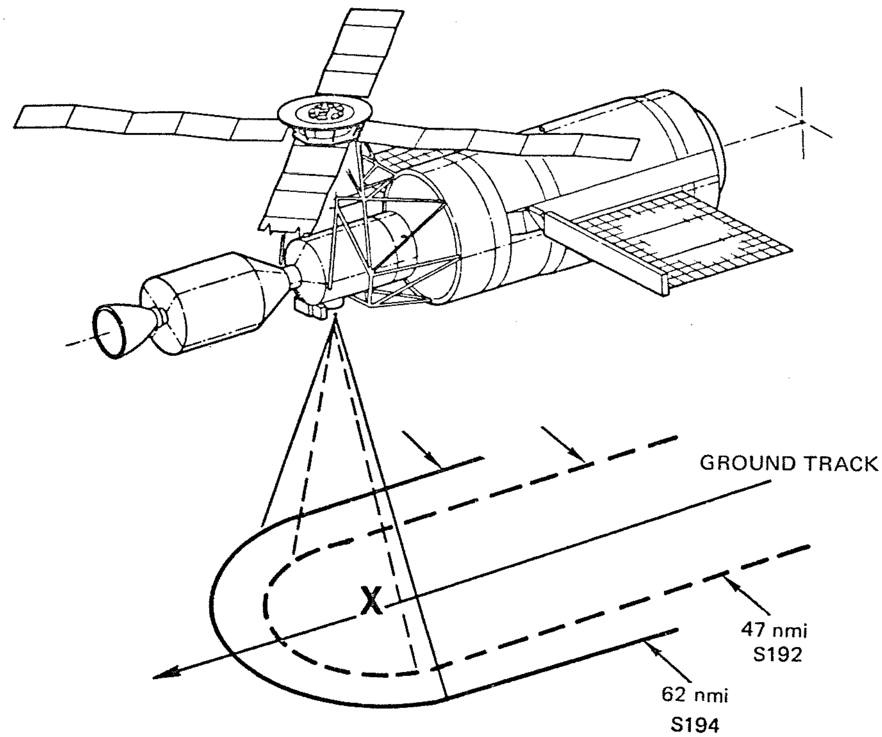


Figure 3-6. Maximum Sun Angle at Orbital Noon

values occur at orbital noon. Figure 3-7 indicates the ground area coverage provided by the Earth Resource Experiment Package sensors from the Skylab orbit.

Two Scientific Airlocks are provided in the Workshop second-floor experiment area. One airlock allows deployment of an experiment directed toward the Sun during solar inertial orientation (solar airlock), the other permits pointing 180 degrees away from the Sun (antisolar airlock). Each scientific airlock is capable of exposing or deploying equipment up to 8.24 inches square. Facilities and equipment (Figure 3-8) for each airlock are identical, including the vacuum service and windows.



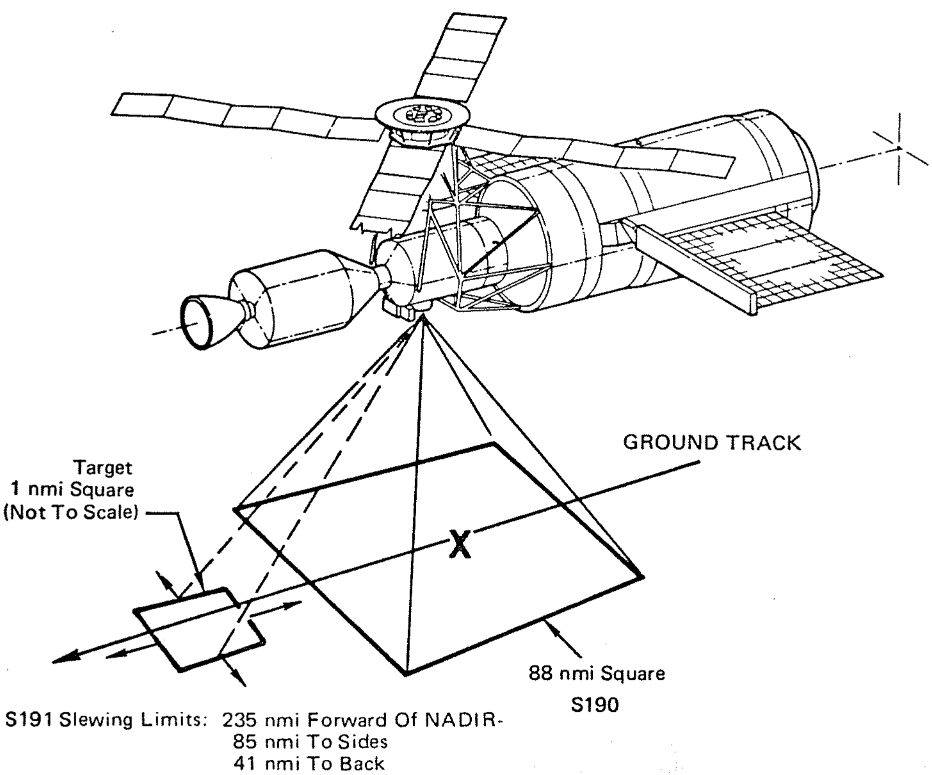


Figure 3-7. Earth Resources Experiment Package Ground Coverage

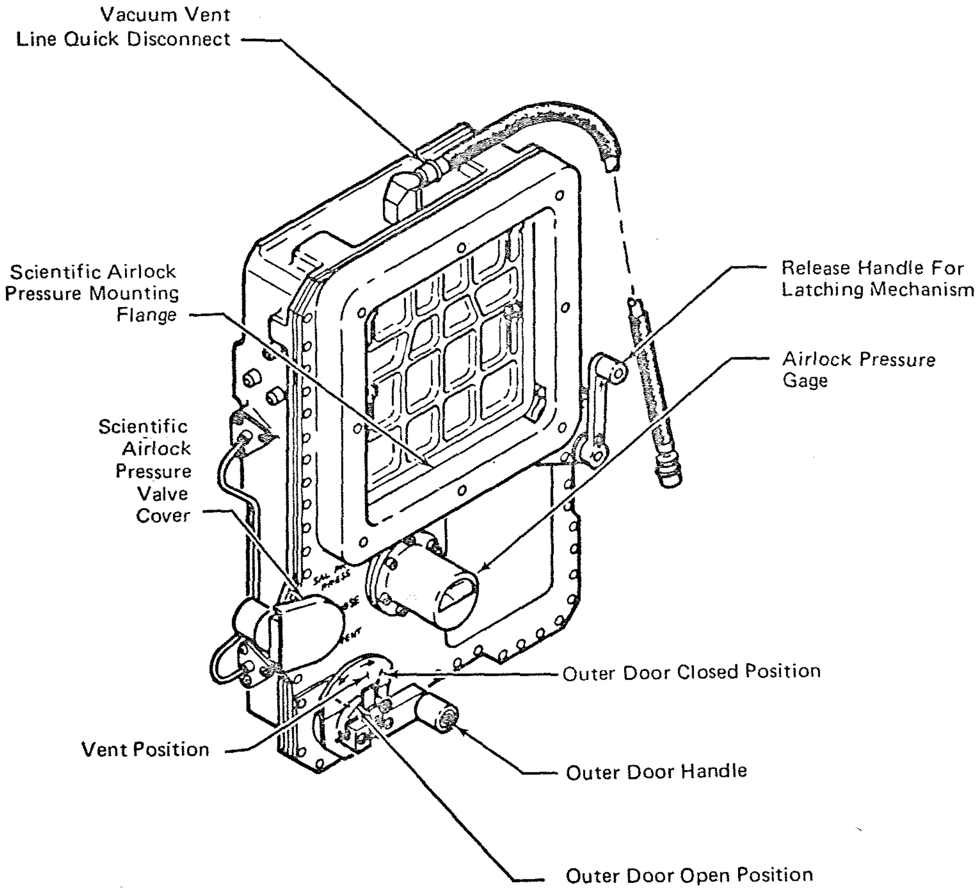


Figure 3-8. Scientific Airlock

Experiments requiring the use of the Scientific Airlocks can be mounted to the airlock, use the Articulated Mirror System (Figure 3-9), or be extended beyond the Workshop skin using the Universal Extension Mechanism (Figure 3-10). The Articulated Mirror System allows scanning of the celestial sphere. The usable entrance aperture is 8 by 8 inches with an approximate field of view of 10 by 10 degrees. The mirror is capable of rotating 0 to 359.9 degrees about the extension axis, and tilts ±7.5 degrees from the nominal position. The Universal Extension Mechanism allows an experiment to be extended up to 18 feet outside the Workshop. The head of this extension mechanism can rotate 0 to 354 degrees about the extension axis and tilt 0 to 112.5 degrees.

The Airlock Module contains four oval windows and support assemblies. Each window is 8 by 12 inches and contains double panes of optical quality glass. The extravehicular activity hatch is equipped with an optical-quality viewing port approximately 8 by 14 inches in size.

An experiment viewing window is also located in the Multiple Docking Adapter. The window has a rectangular viewing area 19.75 by 13.5 inches and contains a single pane of high optical quality, thermally controlled, Borosilicate BK-7 glass.

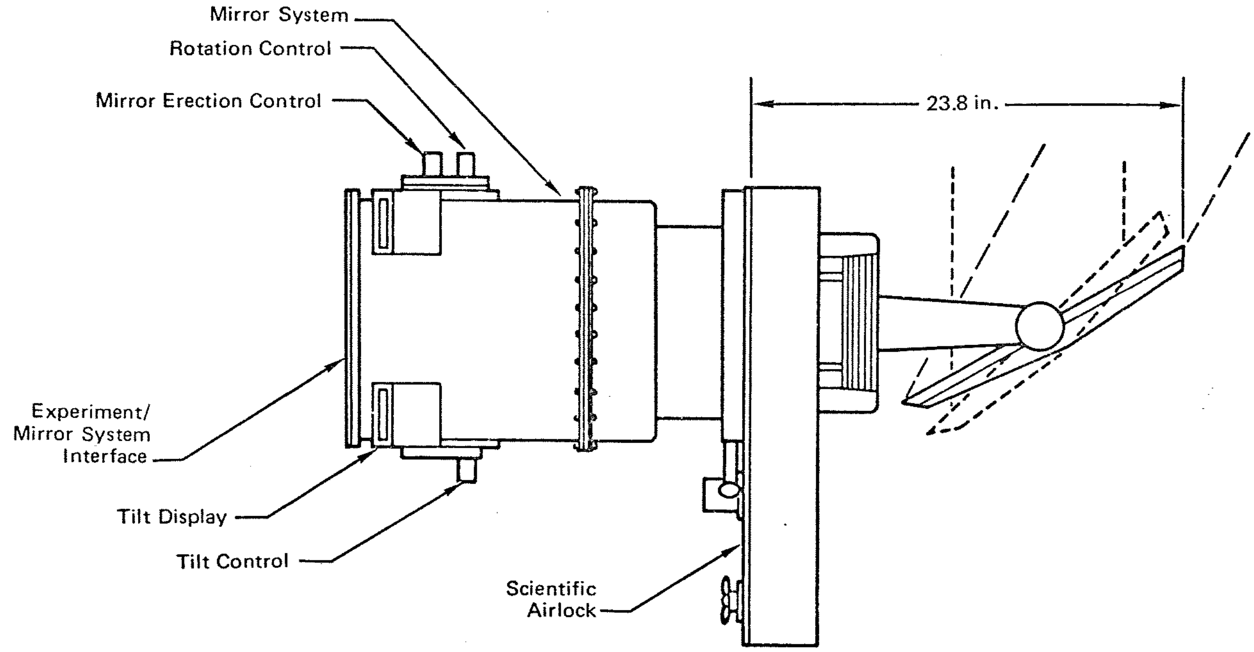


Figure 3-9. Scientific Airlock Articulated Mirror System

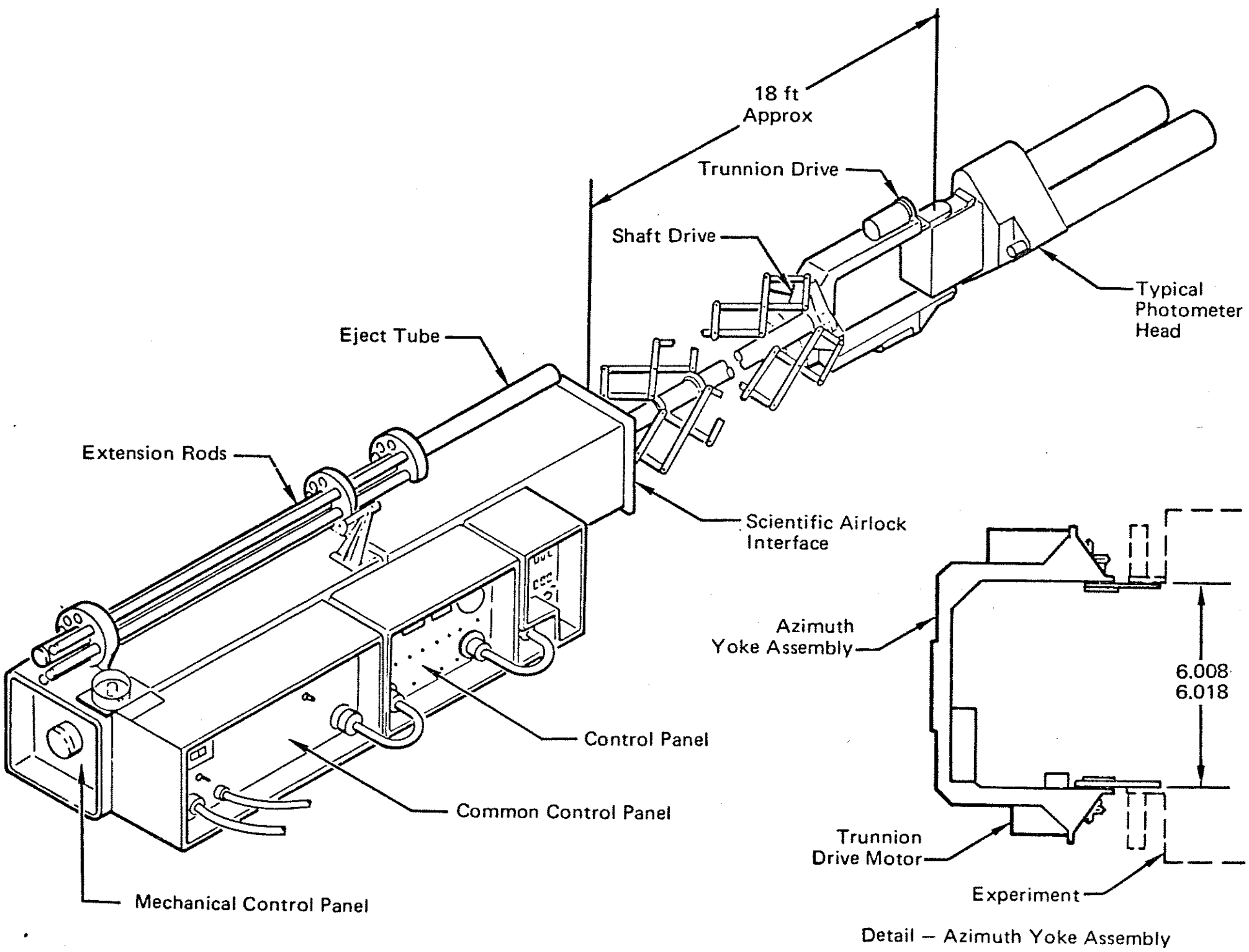


Figure 3-10. Scientific Airlock Universal Extension Mechanism

The time available for viewing a target at a given declination is determined by the rate of orbital nodal regression, altitude, and inclination on minimum viewing angle. These relationships are presented in Figure 3-11.

Figure 3-12 presents a map of the celestial sphere as it appears from the Skylab orbit. However, the capability to view a specific object is limited by the time of the year and the availability of viewing ports. Figure 3-13 shows the location of the viewing ports. Figure 3-14 presents the viewing traces from the centerline of each of these viewing ports on the celestial sphere for each Skylab mission.

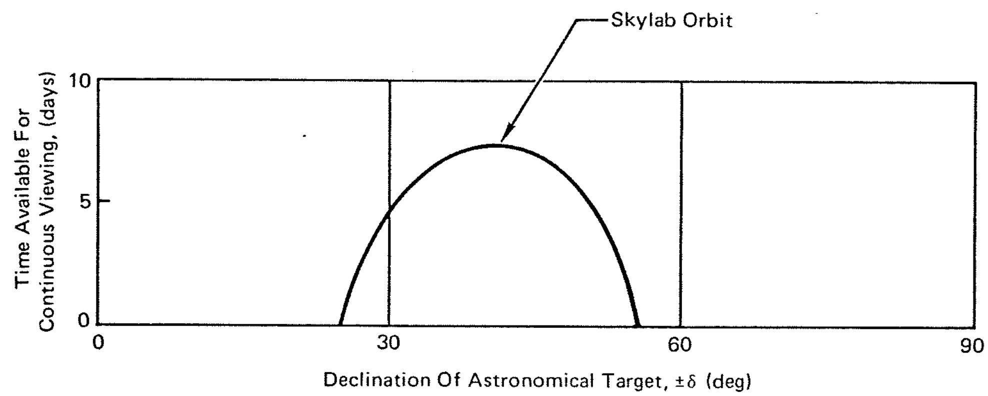


Figure 3-11. Time Available for Unocculted Viewing from Orbit

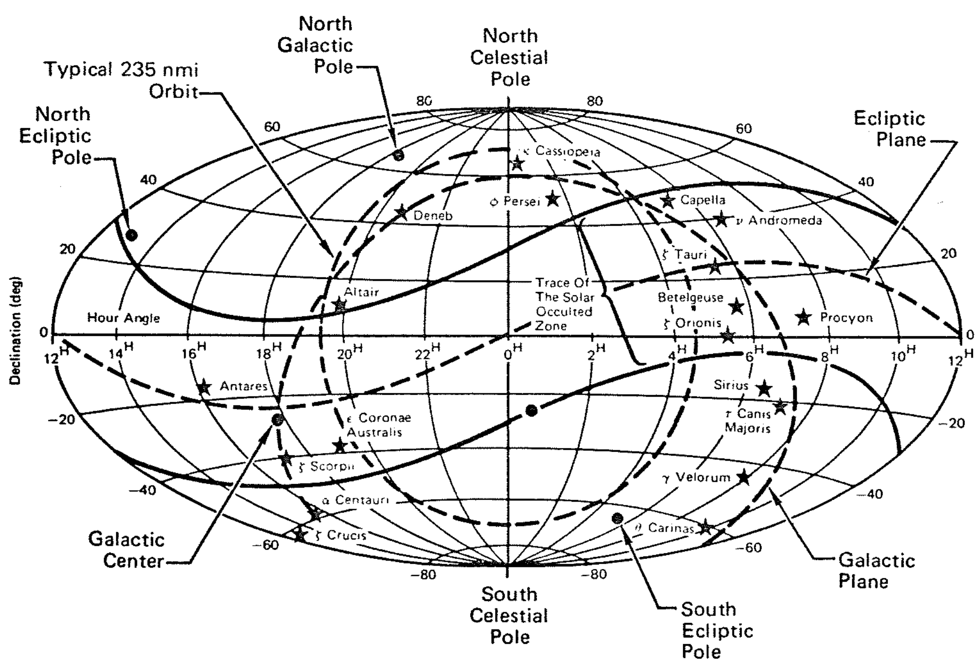
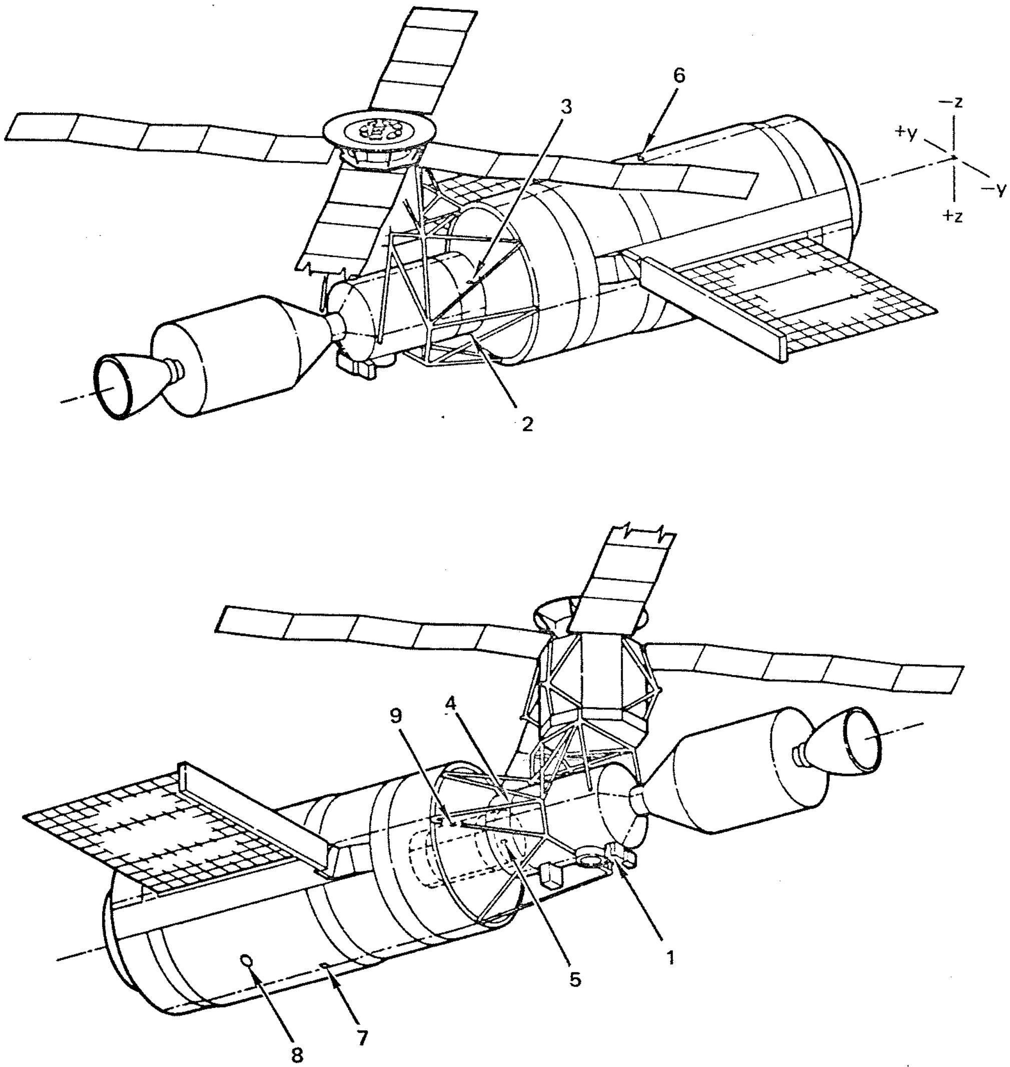


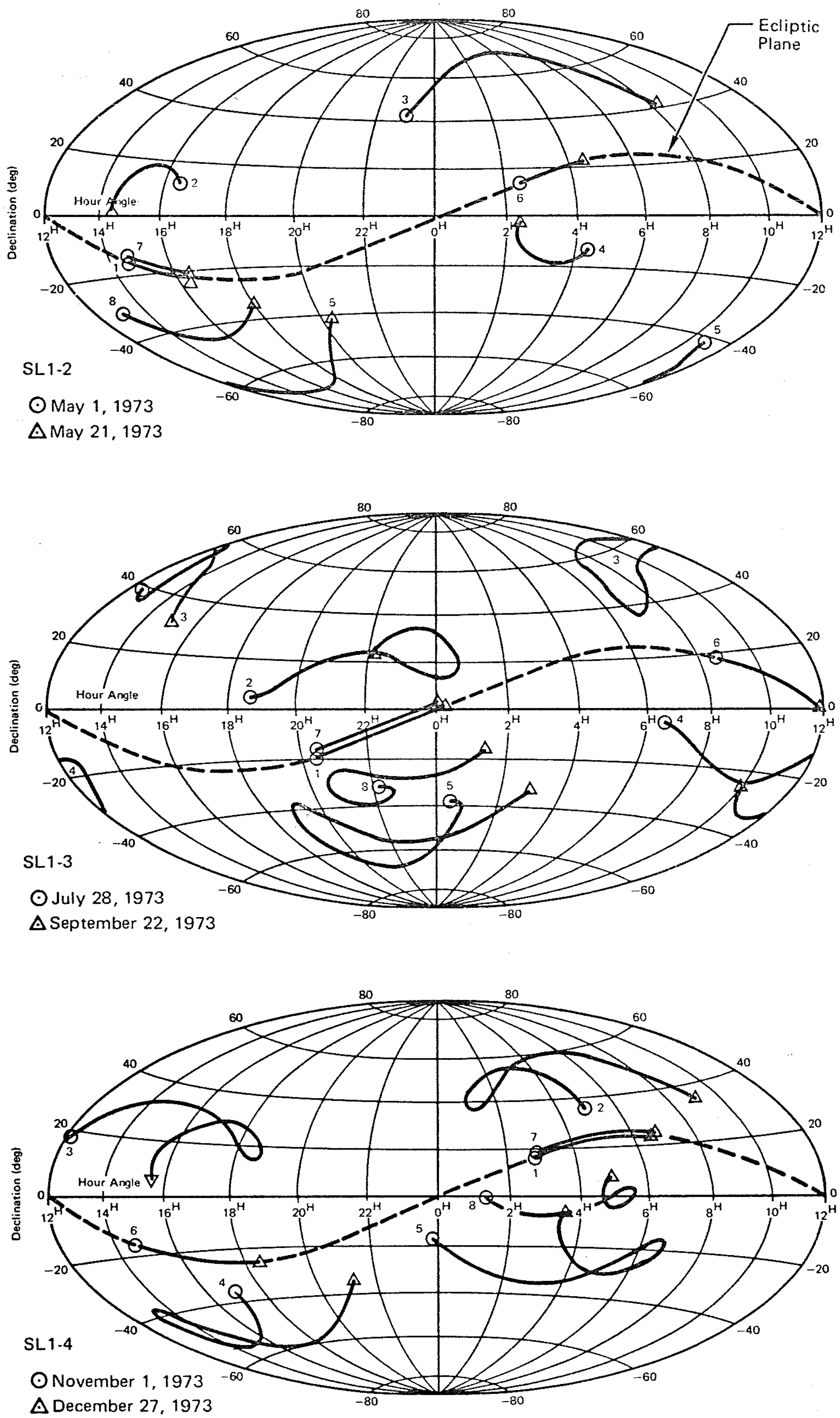
Figure 3-12. Celestial Sphere Map



Port Angular Locations

Port No.	Window Name	Location
1.	S190 Experiment Window	On +z Axis
2.	Airlock Module Window	37.5 deg Off +z Toward −y
3.	Airlock Module Window	37.5 deg Off −y Toward −z
4.	Airlock Module Window	37.5 deg Off −z Toward +y
5.	Airlock Module Window	37.5 deg Off +y Toward +z
6.	Solar Scientific Airlock	0.14 deg Off −z Toward +y
7.	Antisolar Scientific Airlock	4.3 deg Off +z Toward −y
8.	Wardroom Window	25.9 deg Off +z Toward +y
9.	EVA Hatch Window	45 deg Off −z Toward +y

Figure 3-13. Skylab Viewing Ports



1. S190 Experiment Window
2. Airlock Module Windows
3. Airlock Module Windows
4. Airlock Module Windows
5. Airlock Module Windows
6. Solar Scientific Airlock
7. Antisolar Scientific Airlock
8. Wardroom Window

Figure 3-14. Skylab Viewing Port Traces

3.3 EXPERIMENT INSTALLATION

The physical integration of the majority of experiments is illustrated in Figures 3-15 through 3-26. The utilization of available volume, and floor and wall mounting area in each element of the Skylab is indicated.

Workshop Crew Quarters/ Experiment Work Area

The sleep compartment, waste management compartment, and wardroom are generally not available for experiment installation, but the remainder of the lower deck is equipped with experimental apparatus. Shown are the major medical devices used to assess the status of the crew: the Rotating Litter Chair, the Lower Body Negative Pressure Device, and the Ergometer System. The wall-mounted Experiment Support Equipment provides centralized instrumentation and control of the medical experiments conducted in this area. Storage lockers are provided for small experiment items and accessories, such as the Otolith Test Goggles and the Electroencephalography Cap.

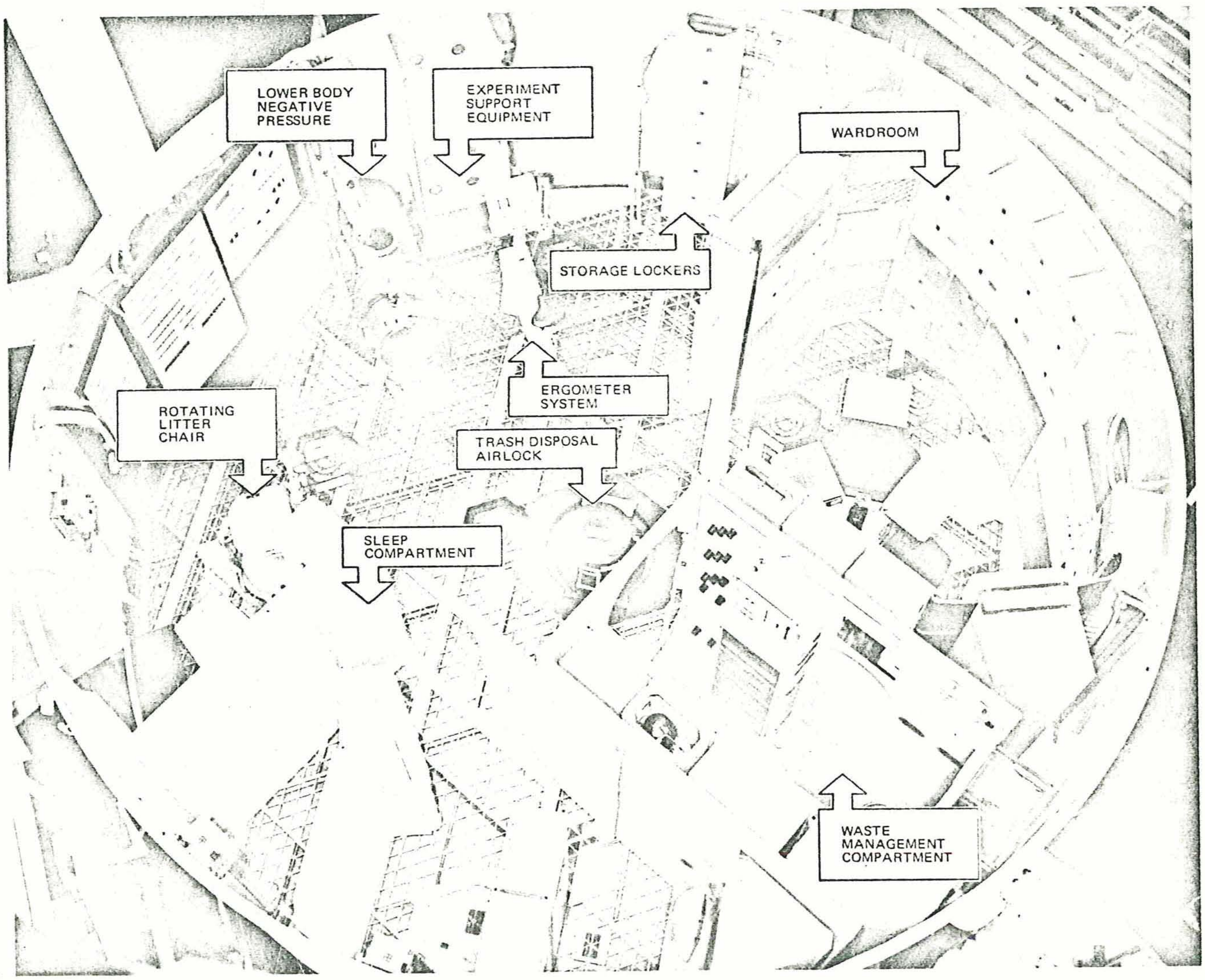


Figure 3-15. Workshop Crew Quarters/Experiment Work Area

Biomedical Experiments Mounting

The methods of mounting these experiments are typical of the methods used throughout the Skylab. The Lower Body Negative Pressure Device and the Rotating Litter Chair are permanently attached to the crew quarters floor. Similarly, other equipment can be installed on the floors, walls, and other structural members of the Workshop, Airlock Module, and Multiple Docking Adapter. Other mounting methods include the use of restraints, tethers, "velcro," or the provision of a dovetail connection which mates with the Skylab Universal Mounting Bracket. This mount is shown in Figure 3-17.

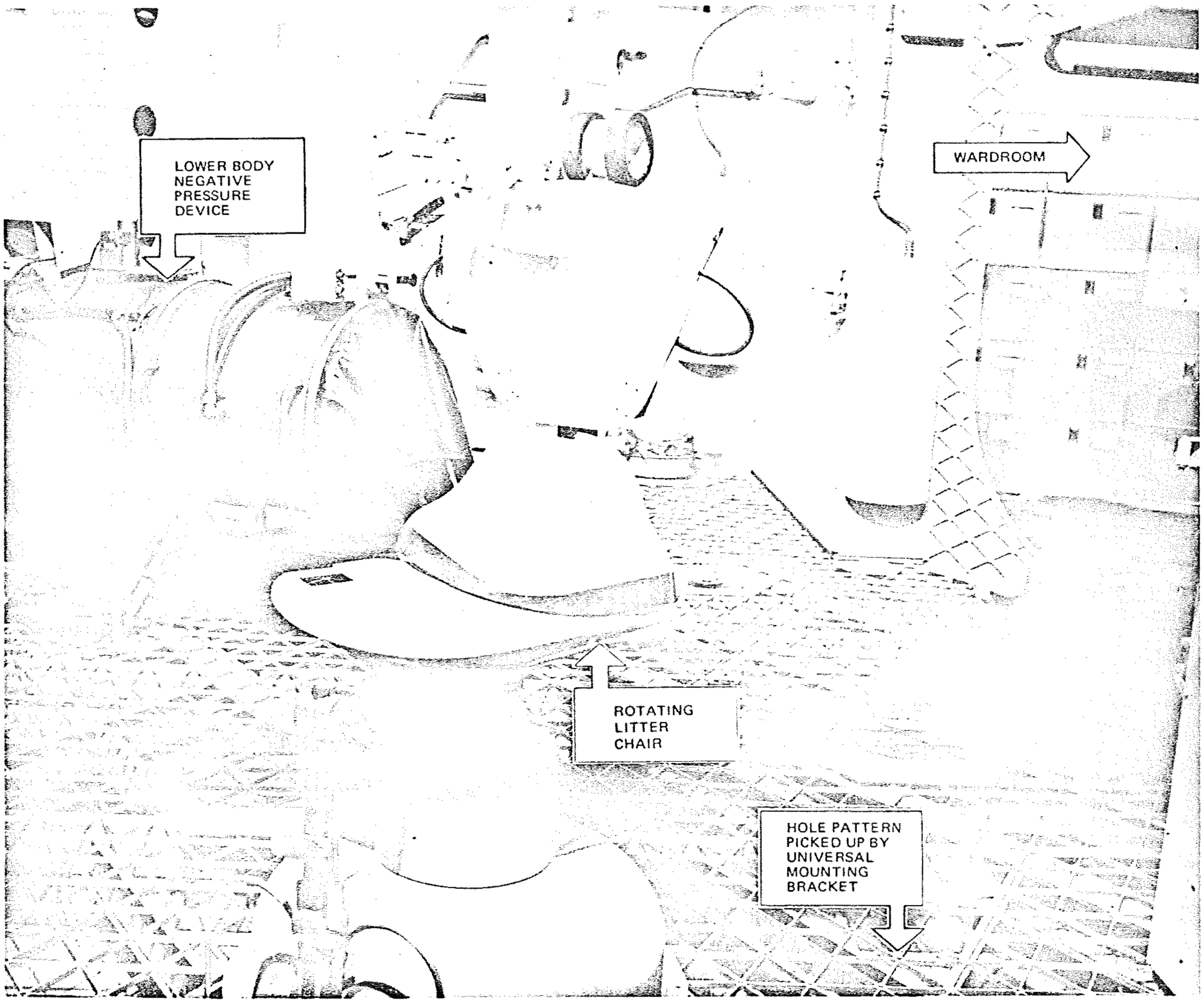


Figure 3-16. Biomedical Experiments Mounting

Skylab Universal Mounting Bracket

This device provides a means of attaching cameras, high intensity lights, and other items to either the floor-ceilings of the Workshop or any of the standard handrails throughout the Skylab.

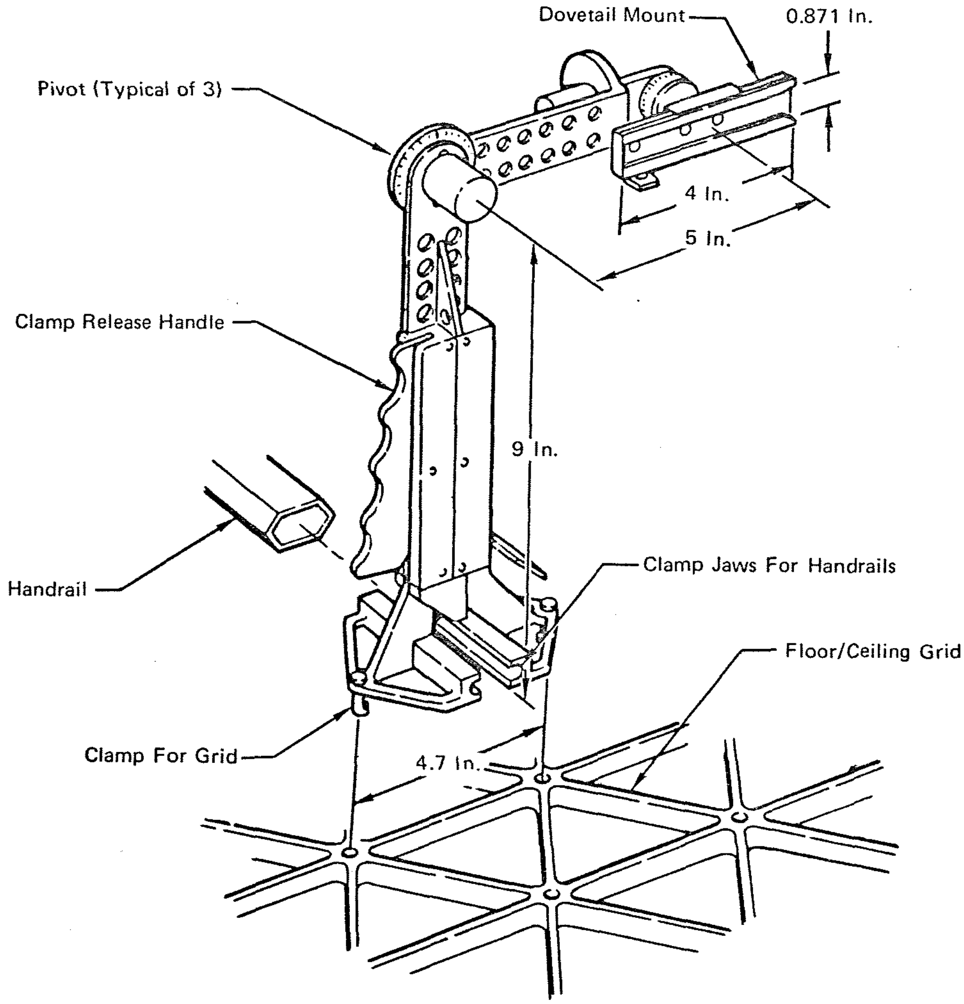


Figure 3-17. Skylab Universal Mounting Bracket

Workshop Second Floor Experiment Area

Three views of the forward experiment area provide an indication of the extensive experiment mounting provisions and volume available. The experiments are shown in the stowed position, either held in place by catches, in racks or contained in lockers attached to the walls and floor-ceiling structure. Sufficient handrails are available to facilitate crew handling and access to the experimental apparatus.

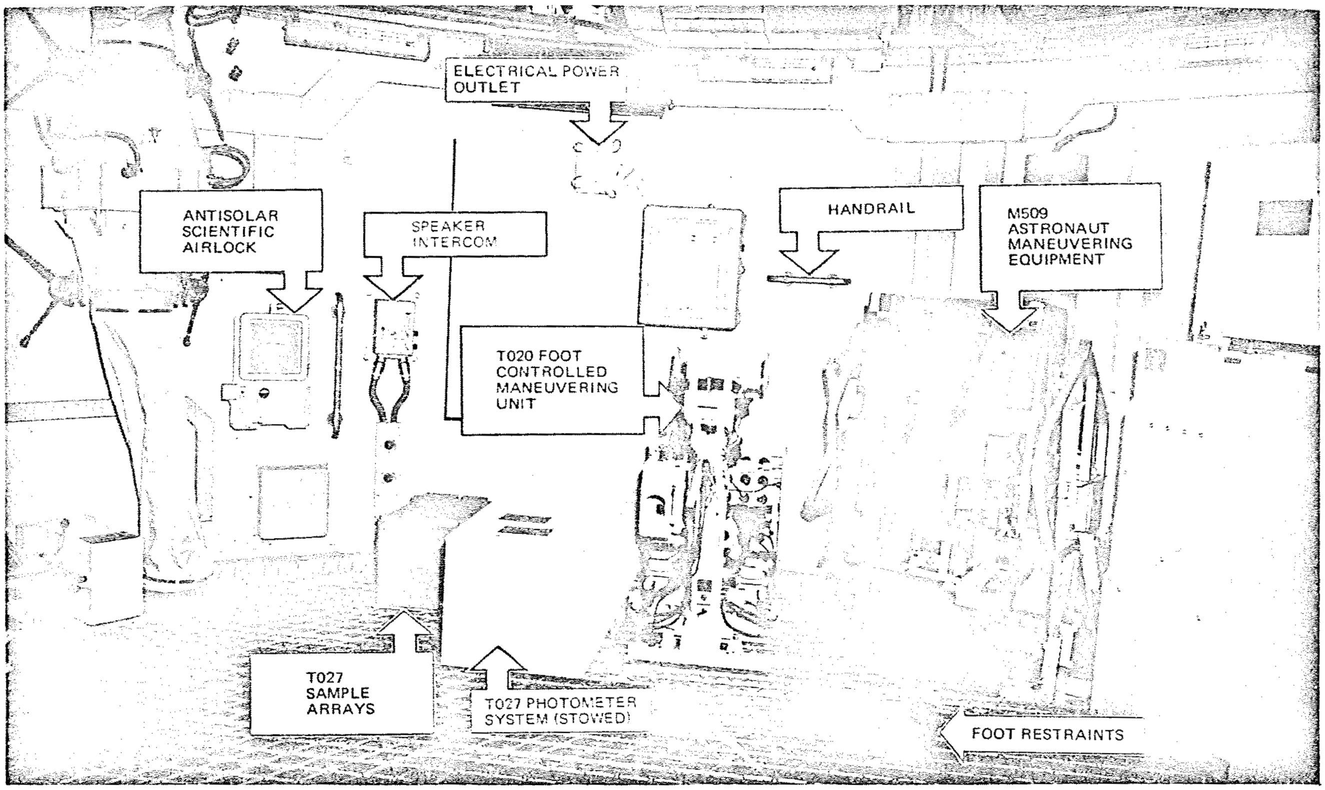


Figure 3-18. Workshop Second Floor Experiment Area – First View

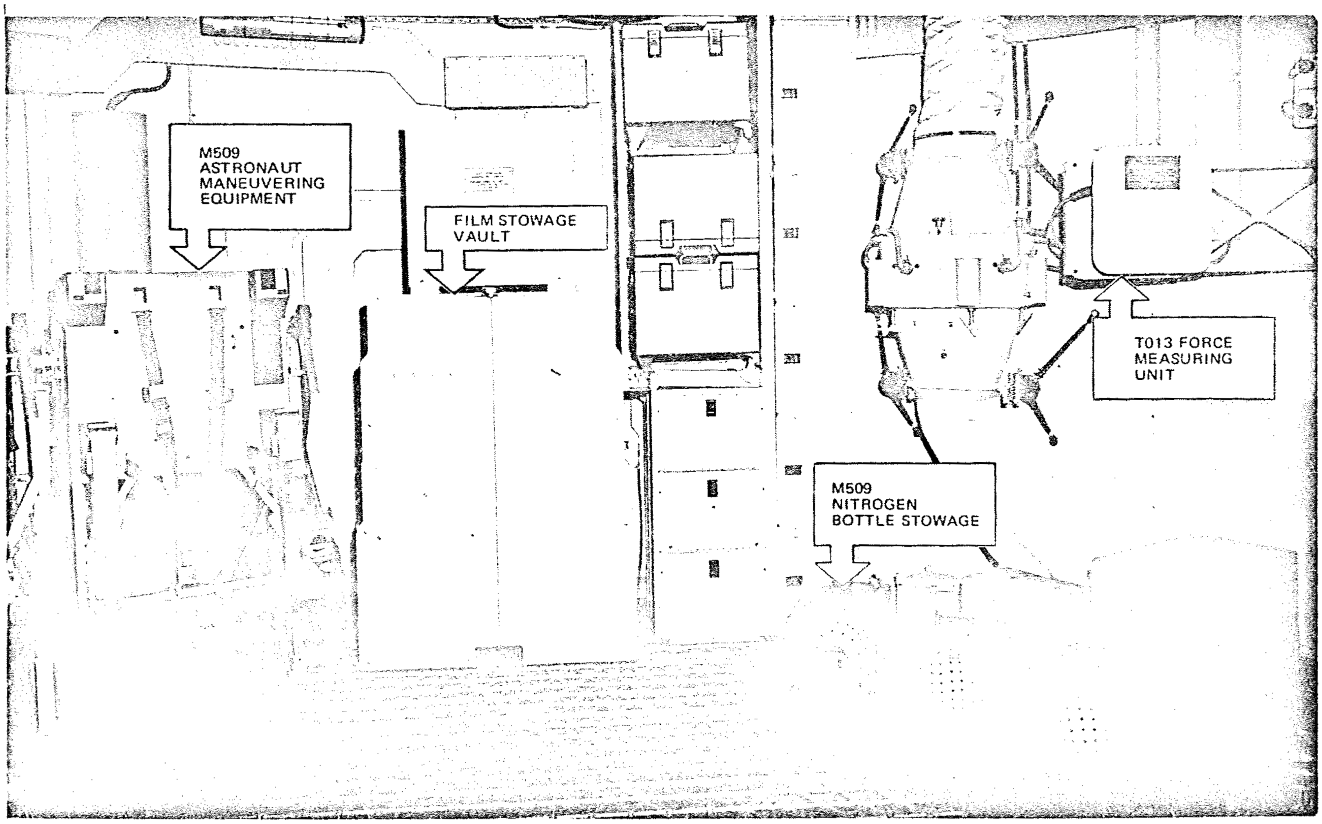


Figure 3-19. Workshop Second Floor Experiment Area – Second View

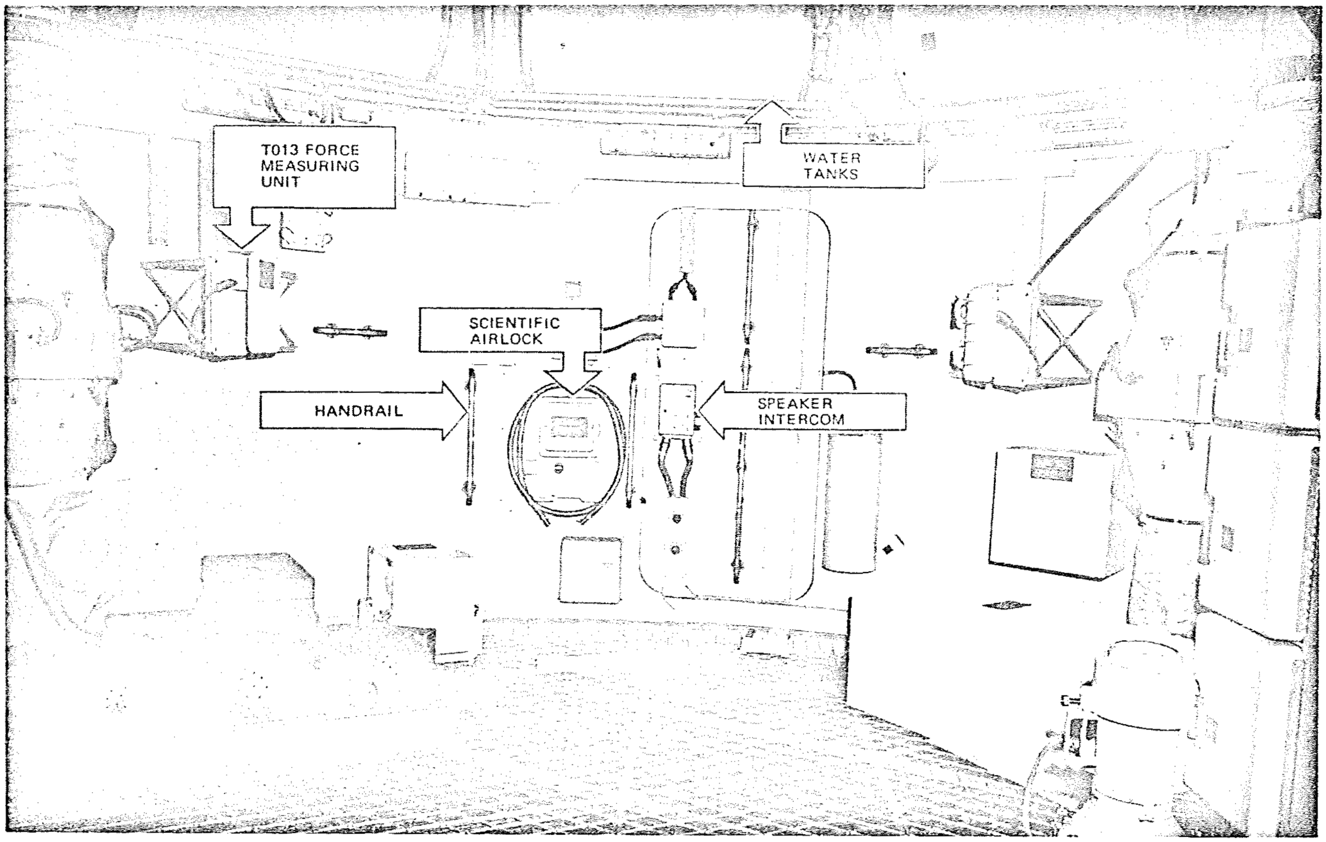


Figure 3-20. Workshop Second Floor Experiment Area – Third View

Airlock Module – Structural Transition Section

The controls and displays installed in the structural transition section form the nerve center of the Skylab. The electrical power and environmental control/life support systems are monitored and controlled from this area. Four optical-quality viewports, which could be used for photographic or other sensing experiments, are provided in this structure.

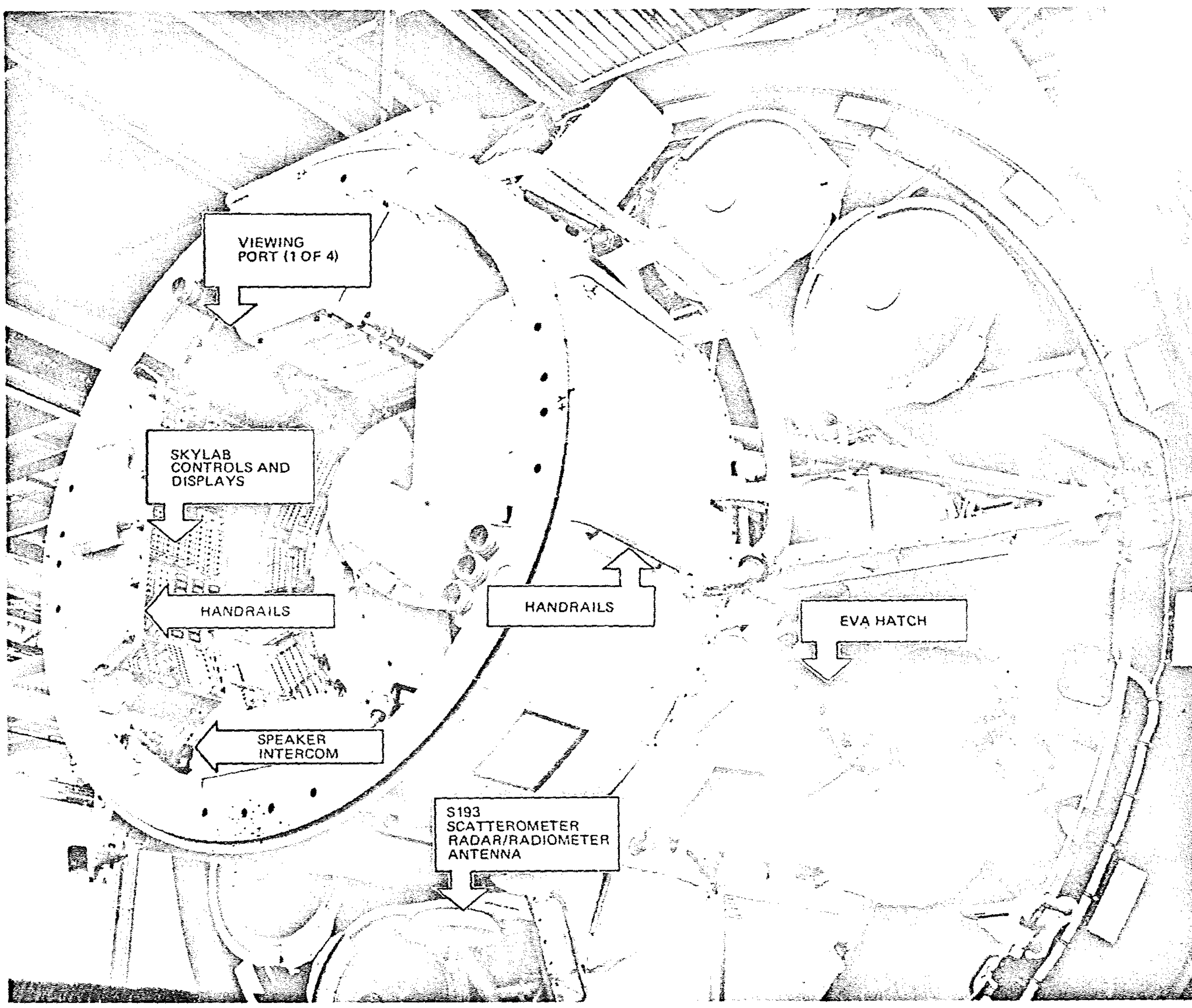


Figure 3-21. Airlock Module – Structural Transition Section

Airlock Module – Tunnel Section

The tunnel section of the Airlock Module provides the facilities which enable the crew to leave the Skylab and perform extravehicular activities to service the Apollo Telescope Mount experiments. Other experiments deployed by the crew include the thermal control coating samples of D024.

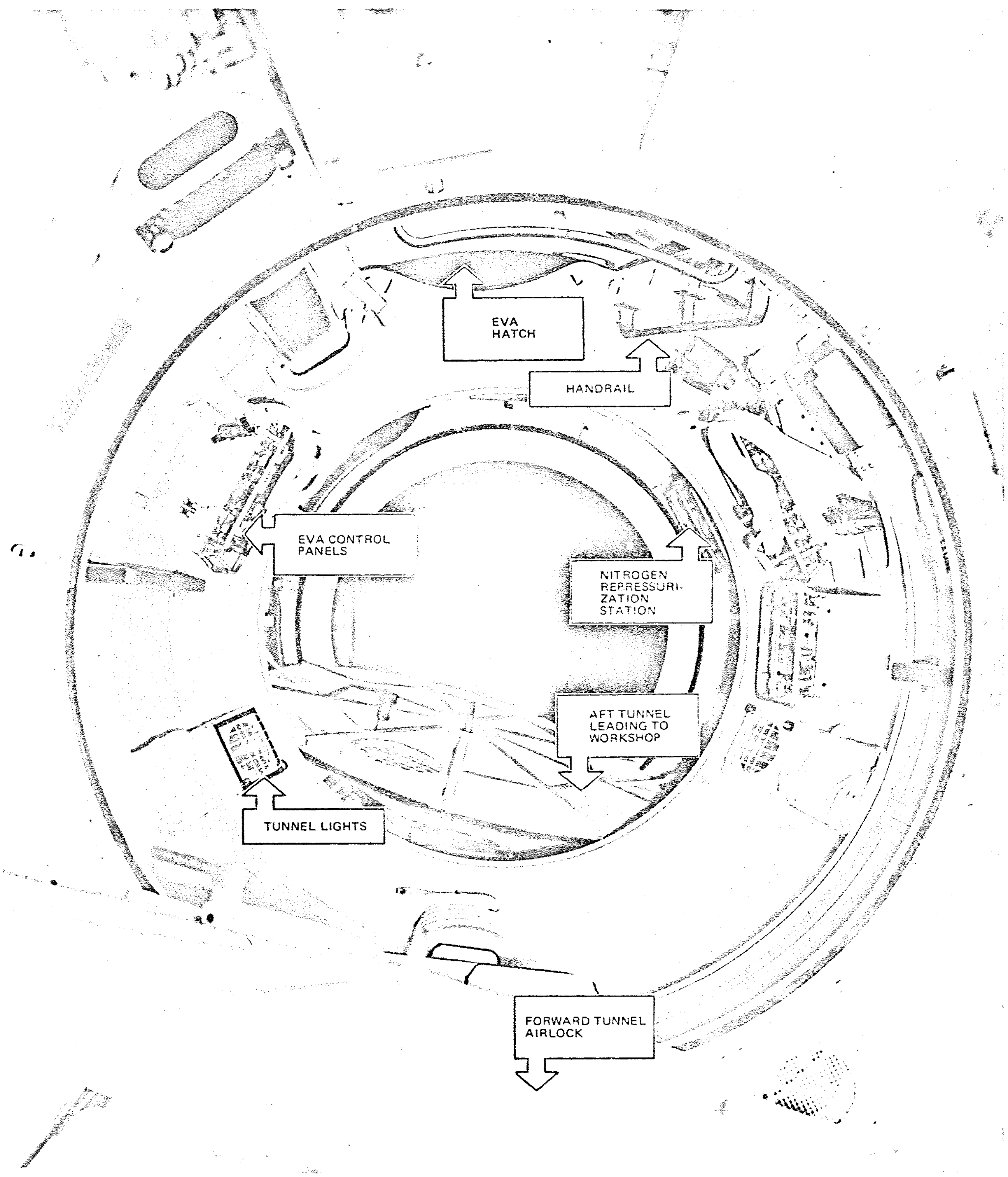


Figure 3-22. Airlock Module – Tunnel Section

Airlock Module – Extravehicular Activity Hatch

When extravehicular activities (EVA) are required, two crewmen don spacesuits, secure the forward and aft tunnel hatches, and connect their spacesuit service umbilicals to the environmental control/life support systems. They then open the EVA hatch and move to the external areas of the Skylab. Normally, one crewman is required to service the Apollo Telescope Mount experiments while the second crewman is available as a safety measure. The extravehicular activity hatch viewing port could be used for photographic or other sensing experiments.

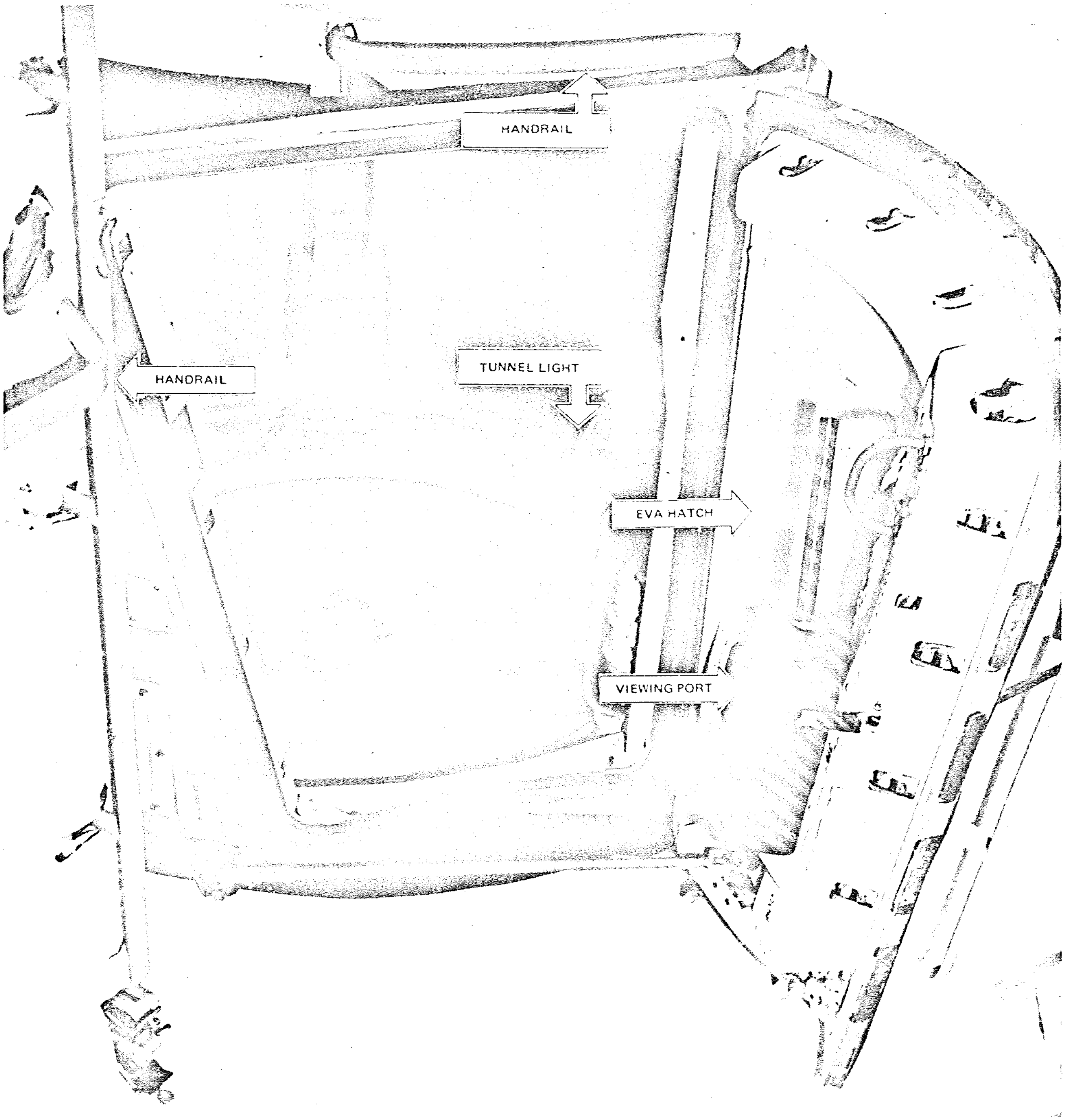


Figure 3-23. Airlock Module – Extravehicular Activity Hatch

Multiple Docking Adapter – General View Three major experimental facilities are located in the Multiple Docking Adapter: (1) Apollo Telescope Mount control and display panel, (2) M512 Materials Processing facility, and (3) the Earth Resources Experiment Package sensors, controls, and tape recorder. The interior arrangement permits crew access to the M512 facility to control and observe individual experiments, and to the Earth Resources Experiment Package sensors and controls for film loading and unloading as well as tape recorder servicing. The three large storage lockers above and forward of the Apollo Telescope Mount control and display panel contain accessories for the Earth Resource Experiment Package sensors.

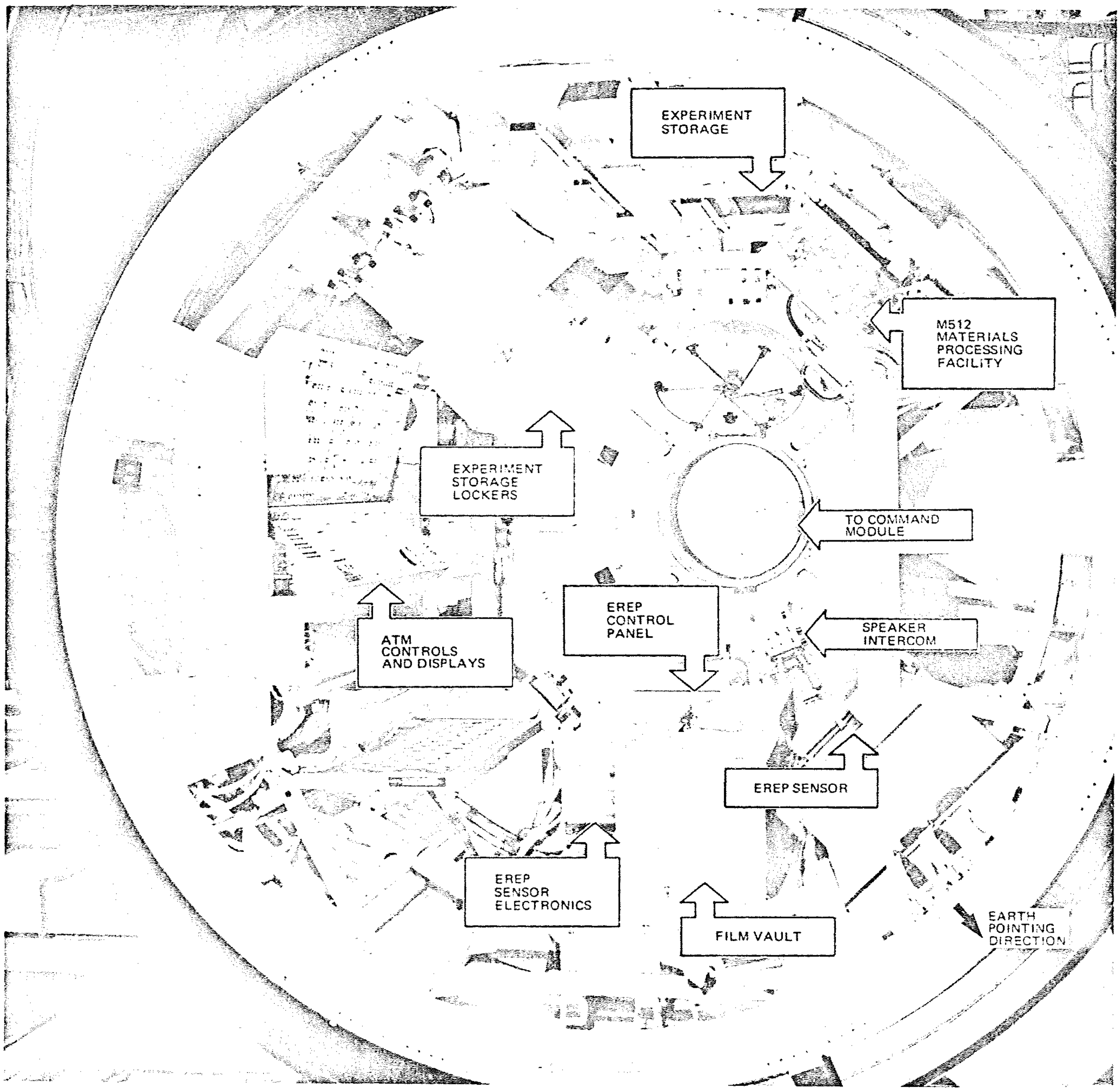


Figure 3-24. Multiple Docking Adapter – General View

Earth Resources Experiment Package Installation

The installation of the S190A Multispectral Photographic Cameras and the S191 Infrared Spectrometer Tracking Telescope are shown. The access cover is hinged on the S190A in the position required for installation of the film magazines. One of the telecommunication system stations is shown in relation to the instruments involved in crew operation of the Earth Resources Experiment Package.

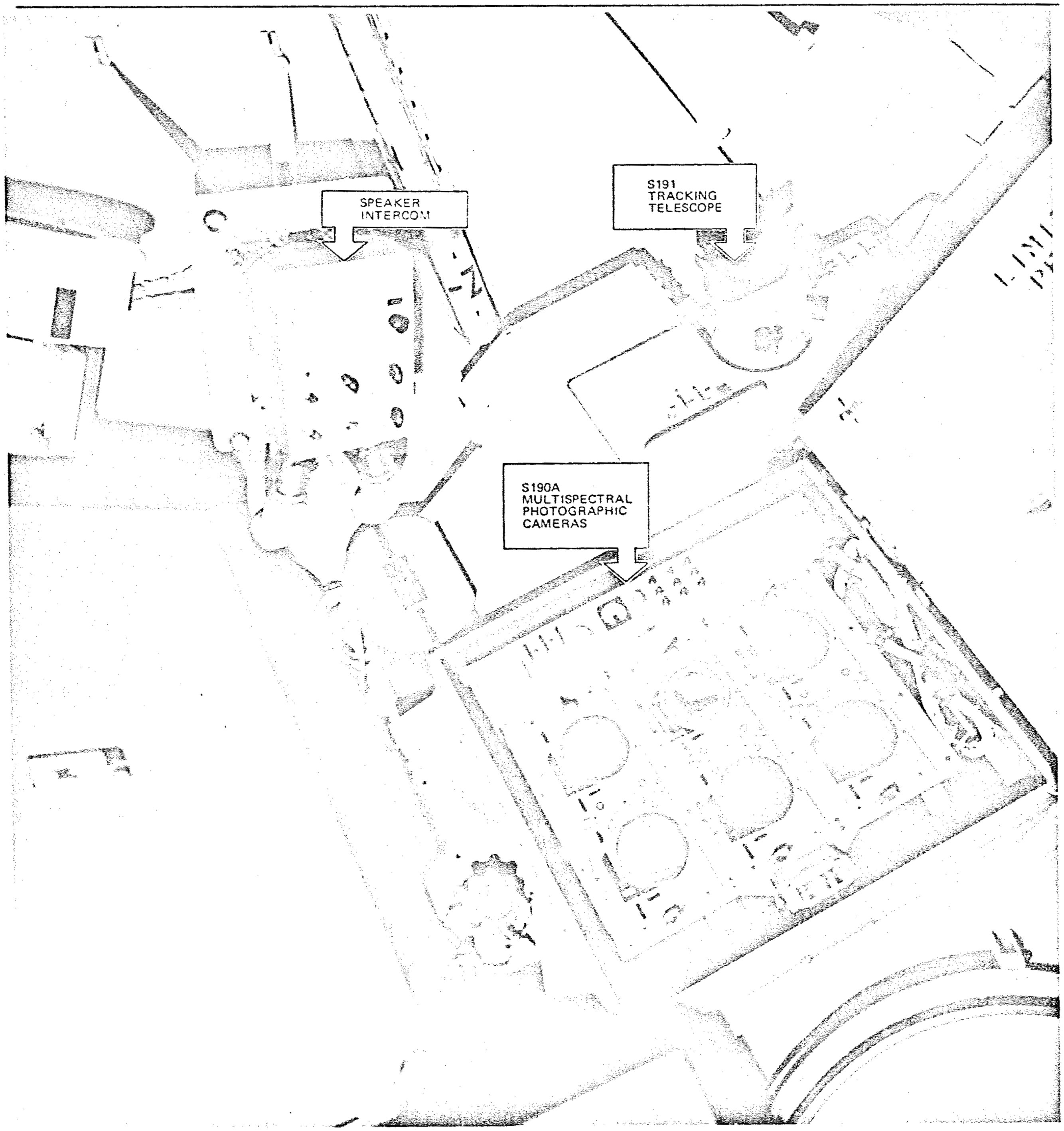


Figure 3-25. Earth Resources Experiment Package Installation

Apollo Telescope Mount — Film Access Quadrant

The experiment canister is positioned with one of the three film access hatches in the open position. A crewman can service the telescopes by changing film magazines from this position during extravehicular activities.

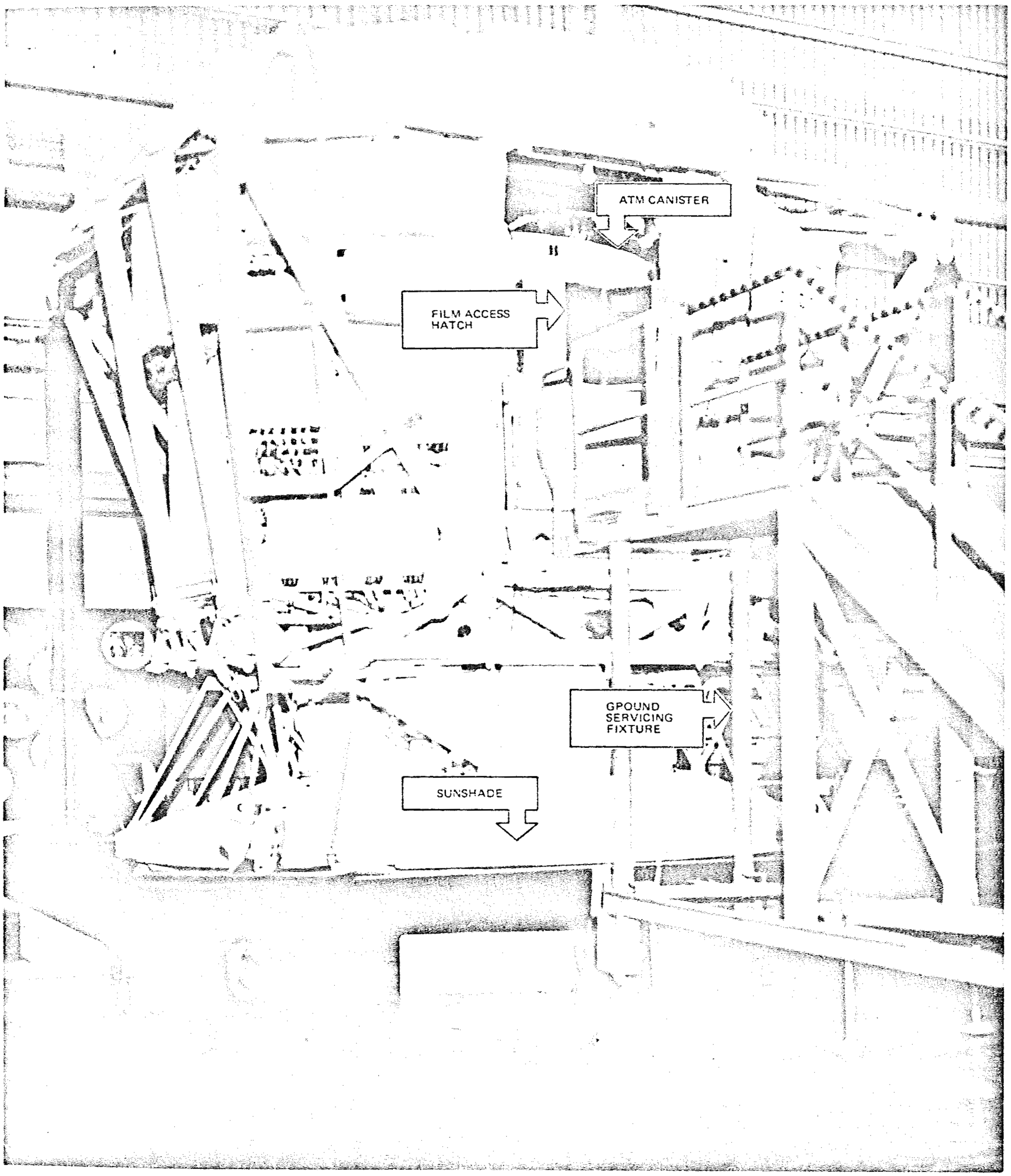


Figure 3-26. Apollo Telescope Mount — Film Access Quadrant

3.4 ELECTRICAL POWER

Individual experiment power demands are provided through scheduling of the experiments so that the average experiment power requirements are on the order of 350 to 550 watts with the peak demands only 2 to 3 times the average demand. Figure 3-27 presents the average power requirement for experiments of a typical day in the first Skylab flight. Electrical outlets, available to experiments, are located in all habitable elements of the Skylab. Table 3-4 indicates the number, location, and power capacity of these electrical outlets.

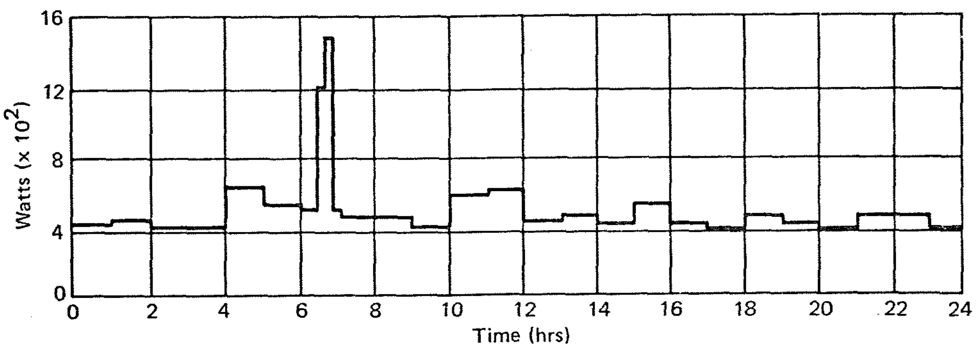


Figure 3-27. Typical Experiments Electrical Load Profile

Table 3-4. Electrical Outlets

Location	Number	Capacity
Orbital Workshop	18	6 amp at 28 vdc
	12	12 amp at 28 vdc
Airlock Module	6	5.4 amp at 28 vdc
Multiple Docking Adapter	4	1 amp at 28 vdc
	2	12 amp at 28 vdc

To provide electrical power for the experiments and the Skylab operational and orbital attitude requirements, two quasi-independent, solar array/battery systems are utilized. One system is located on the Airlock Module/Workshop and the other on the Apollo Telescope Mount. The functional characteristics of these systems are presented in Table 3-5.

Table 3-5. Skylab Power System Characteristics

Total System	
Two-wire, multiple-bus distribution and single-point ground	
Total power (continuous)	7,530 watts
Bus voltage	26-30 vdc
Bus noise	Less than 1 volt p-p, 20 Hz to 20 KHz
Bus transients	Less than ±50v with respect to bus voltage, less than 10 microsec
Transfer between systems	2,500 watts maximum
Transfer to Command and Service Module	2,000 watts maximum
Orbital Workshop System	
Eight charger/battery units and 30 percent depth of discharge	
Power (continuous)	3,814 watts
Apollo Telescope Mount System	
Eighteen charger/battery units and 30 percent depth of discharge	
Power (continuous)	3,716 watts

3.5 EXPERIMENT DATA MANAGEMENT

The Skylab experiment program produces two types of data: (1) physical data including specimens, films, magnetic tape, and log books, and (2) transmittable data including telemetry, voice, and video. Several methods are available through which these data are retrieved. Physical data are returned in the Apollo Command and Service Module. The transmittable data are retrieved via numerous radio frequency links through the Manned Space Flight Network (Figure 3-28).

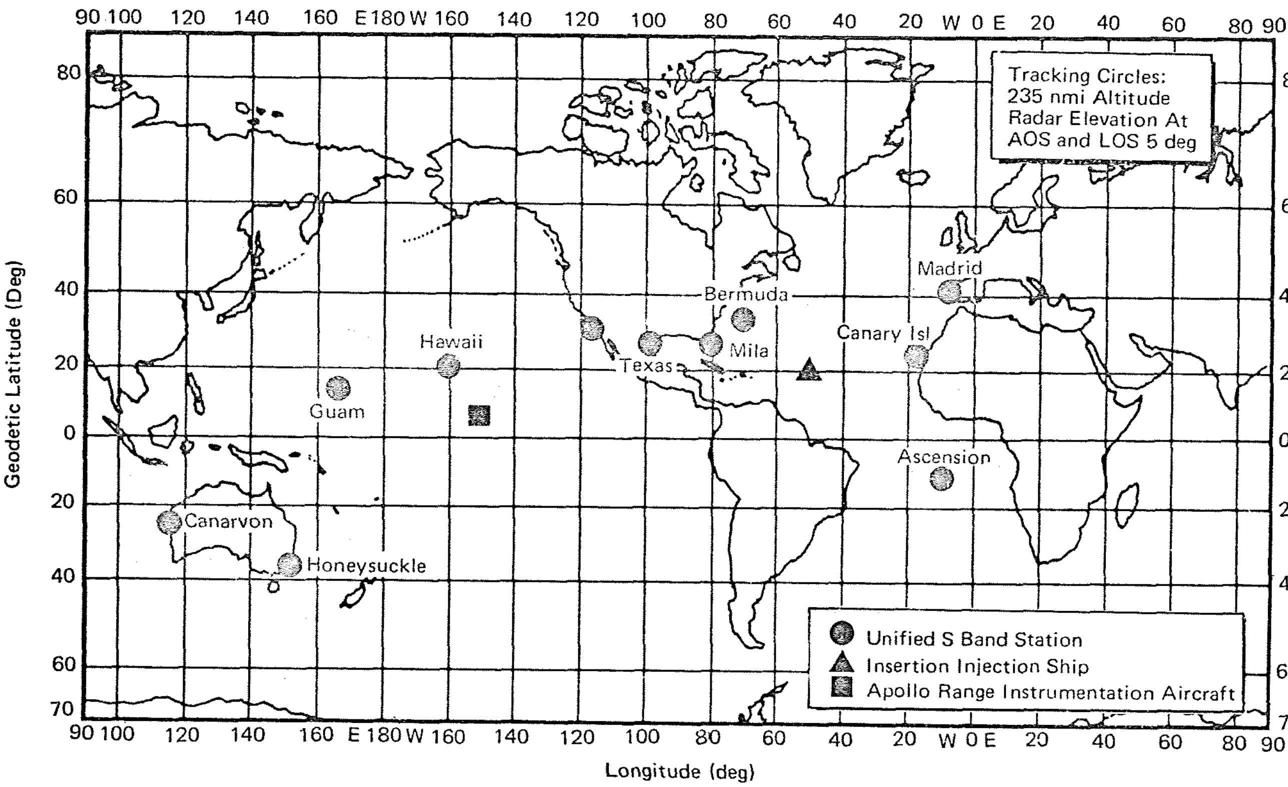


Figure 3-28. Manned Space Flight Network

The Skylab communications system, Table 3-6, provides the links between the Skylab and the Manned Space Flight Network. In addition to real-time telemetry, available about 25 percent of the time with an average contact time of 6.5 minutes, delayed time data and voice are recorded onboard for playback while over a ground station, with the capability to dump 120 minutes of data storage in 5.45 minutes. Television transmission for the five Apollo Telescope Mount cameras and the portable TV cameras via the FM S-band link on the Command and Service Module is also available. A video tape recorder system is also available in the Multiple Docking Adapter. These color cameras can be either hand-held or bracket-mounted and have 525 scan lines at 30 frames per second and operate within a range of 5 to 12,000 foot-candles.

Commands can be sent from Mission Control Center in Houston to turn equipment on and off and to supply data to the onboard computers and the crew. An onboard teleprinter will make hard copies of this information available to the crew. Voice contact with the crew also is available whenever

Table 3-6. Skylab External Communications

Frequency MHz	Power	Modulation	Bit Rate/ Bandwidth	Antenna Type	Antenna Location	Use
230.4	2w	FM/PCM	51.2 kbps	Whip	Airlock Module	Launch T/M
230.4 235.0 246.3	10w 10w 10w	FM/PCM FM/PCM FM/PCM	51.2 kbps 112.6 to 126.72 kbps	Discone (Stub)	Extended from Airlock Module	Orbital T/M, D/T Voice, and data
450.0	NA	FM	200 bps 20 characters per second	Stub/Discone	Airlock Module	Ground-command teleprinter
296.8 259.7	10w NA	AM 3.95 KHz 247Hz 31.6 KHz Tones	NA	Helix	Airlock Module	Command and Service Module ranging
231.9 237.0	10w 10w	FM/PCM FM/PCM	72 kbps 72 kbps		Apollo Telescope Mount solar array	Apollo Telescope Mount telemetry, real time or recorded
450.0	NA	FM	200 bps		Apollo Telescope Mount solar array	Apollo Telescope Mount ground command
243.0		ICW			Command Module	Recovery beacon
259.7 259.7	10w NA	AM AM	NA NA	Scimitar	Service Module	Ranging to Skylab
296.8 296.8 2,106.4 2,287.5 2,272.5	10w NA 2.8w 11.2w Selectable	AM AM PM/PCM PM/PCM FM	NA NA 200 bps 51.2 kbps 2 MHz	Omni	Command Module	Voice, range code to gnd, up data down telemetry TV, T/M

the Skylab is in view of a Manned Space Flight Network station, giving the crew the added capability of comparing and evaluating data. The audio distribution network within the Skylab consists of 14 speaker-intercom assemblies, with two located in the Multiple Docking Adapter, one in the Airlock Module, and 10 in the Workshop. Each speaker intercom assembly permits recording of voice data by the Airlock Module data system and can be used for monitoring five channels of biomed data. During the Skylab missions, facilities will be provided for experimenters in the Mission Control Center at Houston. Limited use will be made of the up-data links as well as the real-time telemetry links.

Specimens, film and magnetic tape will be returned by the Apollo Command Module at the end of each mission. The total weight of such data as a function of experiment type and Skylab mission is presented in Table 3-7.

Prior to return of the Command Module, lockers will be removed and replaced with return canisters or repacked with experiment physical data and samples. Lockers A1 through A9, shown in Figure 3-29, are the principal lockers for data return. Table 3-8 provides a summary of particular

Table 3-7. Command Module Return Data Weights Summary (lbs)

Category	SL-2	SL-3	SL-4
Biomedical Specimens	79	107	104
Solar Astronomy Film	186	372	186
Science Film and Specimens	76	37	12
Earth Resources Film and Tapes	78	78	88
Technology Film and Specimens	68	4	0
Operations Film	52	63	29
Total	539	661	419

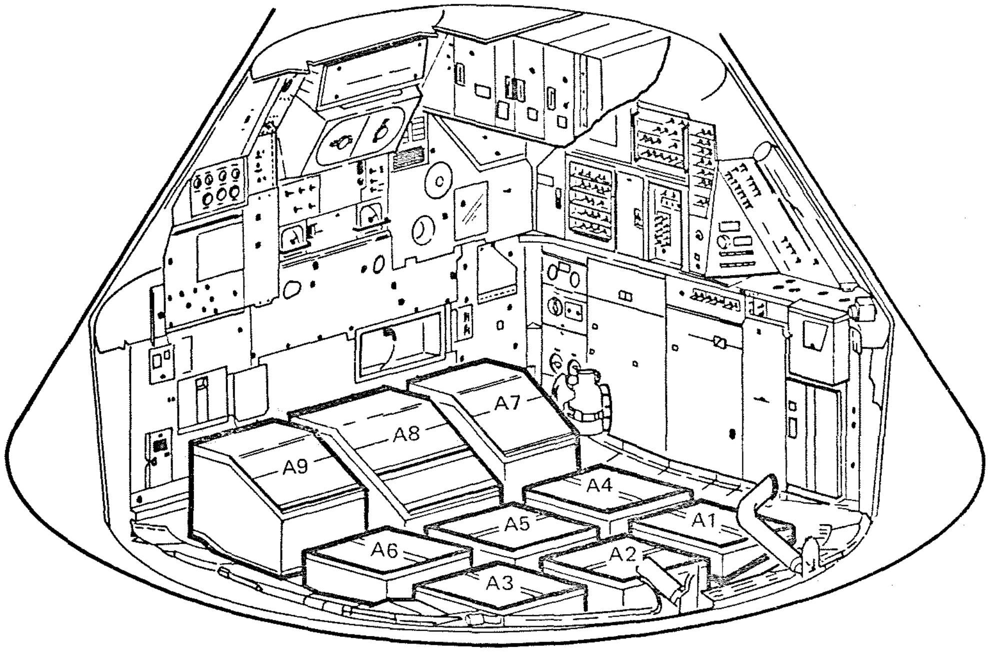


Figure 3-29. Command Module Stowage Compartments and Lockers

experiment data accommodation within the Command Module for each Skylab mission.

The overall data flow from orbit-to-ground is depicted in Figure 3-30. The data requested by an experiment principal investigator will be furnished to him at either Manned Spacecraft Center, Houston, or Marshall Space Flight Center, Huntsville. Any additional data reduction beyond that provided by NASA will be the responsibility of the principal investigator. Following a given time interval, NASA will make the experiment data available to any qualified requestor.

Table 3-8. Command Module Return Storage Allocation

Locker	Volume (ft^3)	SL-2	SL-3	SL-4
A1	1.3	M071 Fecal and Vomitus Samples S082 Camera with Film	M071 Vomitus Samples	M071 Vomitus Samples
A2	1.7	M071 Fecal and Vomitus Samples	M071 Fecal Samples S082 Camera with Film	M071 Fecal Samples
A3	1.3	M071 Fecal and Vomitus Samples S082 Camera with Film	M071 Fecal and Vomitus Samples	M071 Fecal and Vomitus Samples S082 Camera with Film
A4	1.9	S190 Cassette with Film T003 Filter Impactor Container	S082 Camera with Film	S082 Camera with Film
A5	2.1	16mm Film Cassette 400 Ft Tape Recorder S009 Detector Package	M131 Otolith Test Goggles M071 Urine Samples M071 Fecal Samples M071 Vomitus Samples S082 Camera with Film	M071 Fecal Samples M071 Vomitus Samples
A6	1.9	S190 Cassette with Film M512 Specimen Return	16mm Film Cassette 400 Ft S082 Camera with Film	S082 Camera with Film
A7	3.4	M071 Urine Samples EREP Tape Handling Container EREP Tape Reel with Tape Collecting Bag Urine Pool	EREP Tape Handling Container EREP Tape Reel with Tape S149 Detector Cassette Set Collecting Bag Urine Pool S056 Film Magazine	M071 Urine Samples EREP Tape Handling Container EREP Tape Reel with Tape S149 Detector Cassette Set Collecting Bag Urine Pool S056 Film Magazine
A8	5.4	S052 Camera with Film S054 Cassette and Container S056 Film Magazine T027 Sample Array and Canister Assembly	S052 Camera with Film S054 Cassette and Container	S052 Camera with Film S054 Cassette and Container
A9	3.3	S019 Film and Canister S190 Cassette with Film S149 Detector Cassette Set S149 Cassette Containers D024 Sample Panels	S149 Cassette Containers D024 Sample Panels	S149 Cassette Containers

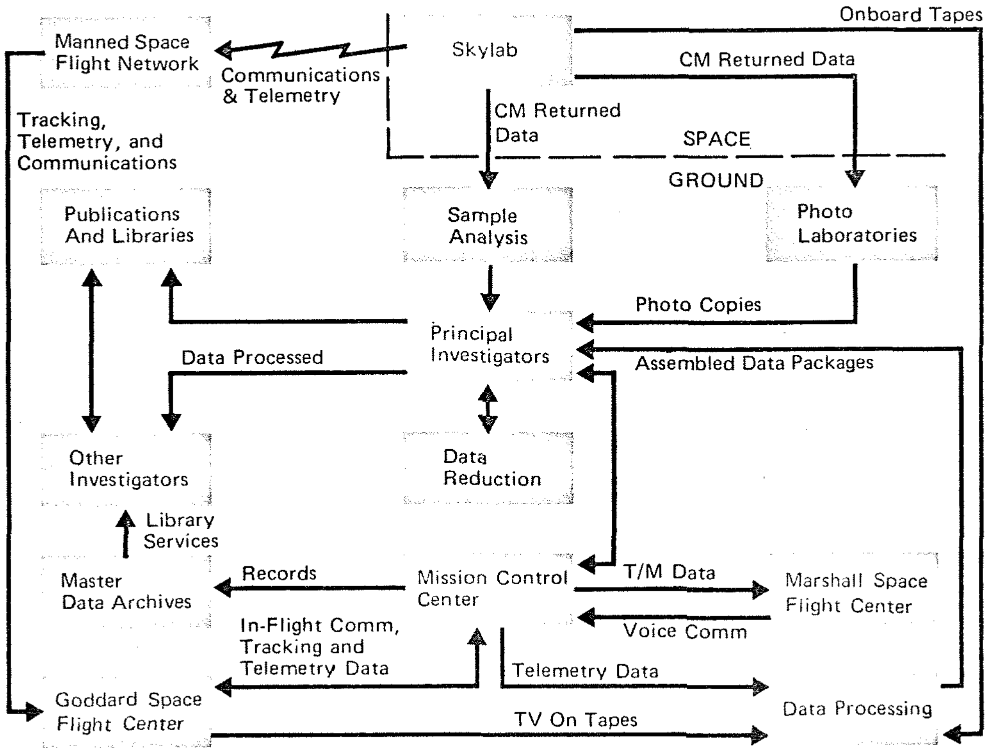


Figure 3-30. Skylab Data Flow Concept

3.6 ENVIRONMENTAL CHARACTERISTICS

Environmental accommodation of Skylab experiments must be considered in two ways: environmental requirements imposed by the experiments themselves, and the environmental effects on the experiments. Experiment environmental requirements address the need for or lack of an atmosphere, or the need for extravehicular activity.

Life support within the Skylab is essentially an open-cycle life support system in which the expendables are not reclaimed for reuse. The atmosphere is a 3.7 psia partial pressure oxygen and 1.3 psia partial nitrogen pressure mixture. The relative humidity is controlled to 26 percent at 85°F. The carbon dioxide concentration is controlled so as not to exceed a maximum pressure level of 5.5 mm of mercury. The temperature in the habitation areas is controlled between 55° and 90°F. Life support and atmospheric consumables include: 6,000 pounds water; 1,470 pounds food; 4,930 pounds oxygen; and 1,320 pounds nitrogen. Environmental operating limits are presented in Table 3-9.

Table 3-9. Environment in Crew Quarters

	Temperature (°F)	Relative Humidity (%)	Pressure (mmHg)	Gas (%)
Prelaunch – Operational	40 to 80	0 to 40	760 to 1,350 Max	20 O_2 80 to 100 N_2
Prelaunch – Nonoperational	0 to 160	30 to 45	870 to 1,350	Air
Launch and Ascent	40 to 110	0 to 40	1,200 to 1,350	100 N_2
Operational Orbit	55 to 90	25 to 85	250 to 270	28 N_2 72 O_2
Orbital Storage	40 to 85	25 to 100	25 to 320	28 N_2 72 O_2

The Skylab systems have been designed to ensure that overall sound pressure level is no greater than 72.5 db when the summation of the individual sound pressure levels from all sources is considered at any given time.

The orbital acceleration levels onboard the Skylab are due to drag, gravity gradient torques, venting, crew motion, thruster operation, stabilization, and Command and Service Module docking. The maximum linear, radial, and tangential acceleration imposed by these disturbance sources are within a range of 10^{-1} to 10^{-7} g. During normal experiment operations, acceleration levels between 10^{-5} and 10^{-7} can be expected. Acceleration and vibration levels encountered during launch are limited to about 4.4 g's and 3.7 g^2/Hz at 100 Hz, respectively. Reentry loads within the Apollo Command and Service Module are limited to about 3 g's.

3.7 TOOLS AND OTHER SUPPORT EQUIPMENT

There is a considerable array of tools, miscellaneous supplies, and support equipment for the crewmen in the Skylab. These include tool kits, repair kits, restraints, supplies, a film vault, photographic equipment, and TV cameras. Two tool kits are installed and retained in standard stowage lockers. The tools provided include standard ranges and sizes of sockets, open end/box wrenches, screwdrivers, and screwdriver bits. Also included are a vise, a speeder handle, a spin-type handle, a ratchet handle, a pin straightener, and other common type handtools.

A repair kit is also installed in a standard stowage locker. This kit contains the necessary type and sizes of blister patches to repair structural leaks. Additional items provided include flat patches, teflon tape, sealant putty, "velcro" fasteners, restraints, scissors, and tape for repairing air duct damage.

Another support kit includes tension and compression scales, a steel measuring tape, a sound level meter, a frequency analyzer, a surface temperature thermometer and three ambient thermometers.

Cameras using both film and television are provided. To support the film cameras, there is a film vault to provide protection from radiation. Photographic lights, power and signal cables, versatile mobile restraints, and convenience outlets are provided. The film cameras available for use inside the Skylab include a 16 mm Data Acquisition Camera (frame rates 2, 4, 6, 12 and 24 frames per second with shutter speeds from 1/60 to 1/1,000 of a second), 35 mm, and 70 mm still cameras. Speed, resolution and coverage depend upon film and lens selected.

Brief descriptions of the experiments planned currently for the Skylab missions are presented later in this section. These descriptions provide (1) the purpose of the experiment, (2) the significance of the experiment, (3) the experiment equipment, and (4) the crew involvement if required for clarity. Also included are photographs of the principal equipment or installation of the equipment in the Skylab.

In addition to the Skylab experiments, opportunities have been offered for secondary school students to participate in the Skylab Program by proposing experiments to be conducted during the missions. The National Science Teachers Association and NASA jointly are sponsoring and conducting the Skylab Student Project. A listing and brief description of the selected proposed experiments and demonstrations which will be performed are also included.

4.1 EXPERIMENTS – OBJECTIVES

The six categories of experiments capitalize on the unique opportunities available in Earth orbit. The Earth resources and solar astronomy observations and the scientific experiments take advantage of the vantage point and disturbance free environment which the orbit can offer the investigator to make observations and measurements not possible from terrestrial or airborne observatories. The technology and operations experiments rely on special and unique properties of the space environment to examine phenomena, materials processes and techniques in a manner also not possible on Earth. The medical investigations are directed at determining the adaptation of man to the Skylab environment.

4.2 EXPERIMENT PURPOSE AND EQUIPMENT

The purpose and equipment used for each of the six experiment categories are described for each Skylab experiment.

4.2.1 Earth Resources Experiment Package Observations

Experiment No.	Title
S190	Multispectral Photographic Facility comprised of:
S190A	Multispectral Photographic Cameras
S190B	Earth Terrain Camera
S191	Infrared Spectrometer
S192	Multispectral Scanner
S193	Microwave Radiometer/Scatterometer and Altimeter
S194	L-Band Radiometer

Skylab offers an opportunity to expand remote sensing investigations of the Earth from orbit by utilizing relatively large aperture, flexible, high-performance sensors, and by utilizing the crew to operate the sensors under laboratory conditions. The Earth Resources Experiment Package (EREP) represents an experimental facility dedicated to that purpose.

The EREP permits quantities of remotely sensed data to be gathered, enabling many participants to apply the data immediately. This will establish the value and usefulness of Earth-survey techniques. The planned experiments relate to assessments of sensor types, designs, and capabilities needed to identify specific Earth resources and features. Requirements for specific applications to future systems can then be more firmly established. Methods for processing and interpreting data and the effects of atmospheric scattering and attenuation will also be defined.

The EREP facility includes six sensors together with their associated support equipment. The support equipment includes the electronics associated with each sensor, a control and display panel, and a tape recorder and a spare.

Two crewmen are required to operate the sensors. The control and display panel contains individual switches which activate and select the operating modes for five of the EREP sensors. Also included are master power switches and the controls for the tape recorder. The assigned crewman is responsible for operating each of the sensors from the control and display panel during their functional periods. Other functions of the crew involve attaching the S190A boresighted camera array to the mount support assembly in its operational position over the photographic viewing window. Supply and return of film cassettes for the S190A array and the 16 mm camera, used with the S191 Infrared Spectrometer, also are required. A crewman operates the tracking telescope and slewing control of the S191 Spectrometer. The S190B Earth Terrain Camera is deployed by the third crewman to view through the anti-solar scientific airlock in the Workshop. Film supply and retrieval from this instrument also is accomplished by this crewman.

Another major function of the crew involves coordination with ground-based activities and Mission Control to update the scheduling and conduct of EREP passes to the flight plan. Real-time decisions are required because of local weather and cloud cover conditions. This important manned function will optimize the utilization of the EREP and, therefore, maximize Skylab's contribution of useful data to the principal investigators.

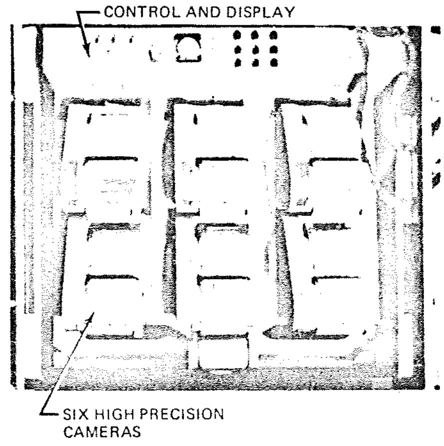
S190A MULTISPECTRAL PHOTOGRAPHIC CAMERAS

PURPOSE: Obtain precision multispectral photography which will provide a basis for a wide range of earth science studies. Detail not apparent in ordinary photography can be studied

SIGNIFICANCE: Utilizing this technique, features can be observed such as: water pollution, geological features, development of metropolitan and urban areas.

EQUIPMENT USED:

- Multispectral Photographic Facility
- Earth Resources Experiment Package Support Equipment



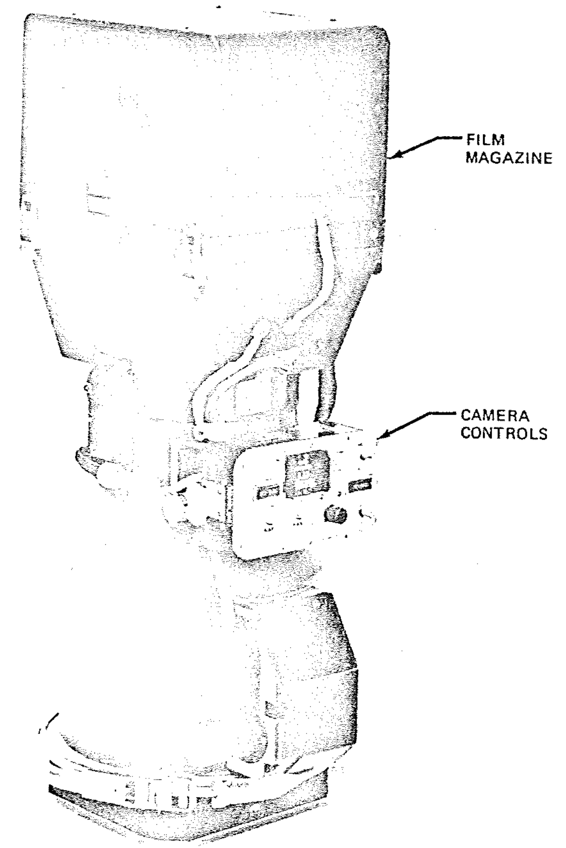
S190B EARTH TERRAIN CAMERA

PURPOSE: Supply high-resolution data of small areas within the fields of view of the Earth Resources Experiment Package sensors to aid in interpretation of the data gathered by these instruments.

SIGNIFICANCE: The camera will offer the first opportunity to obtain high-resolution Earth photography from a manned spacecraft. The anticipated resolution will be a marked improvement over prior photography obtained on manned flights to date or the photography of the S190A camera.

EQUIPMENT USED:
- Earth Terrain Camera

CREW INVOLVEMENT: One crewman will be required to unstow the camera, install it in the Scientific Airlock, operate the controls and restow the camera. Loading and unloading film to be returned in the Command Module will be required for the camera magazine.

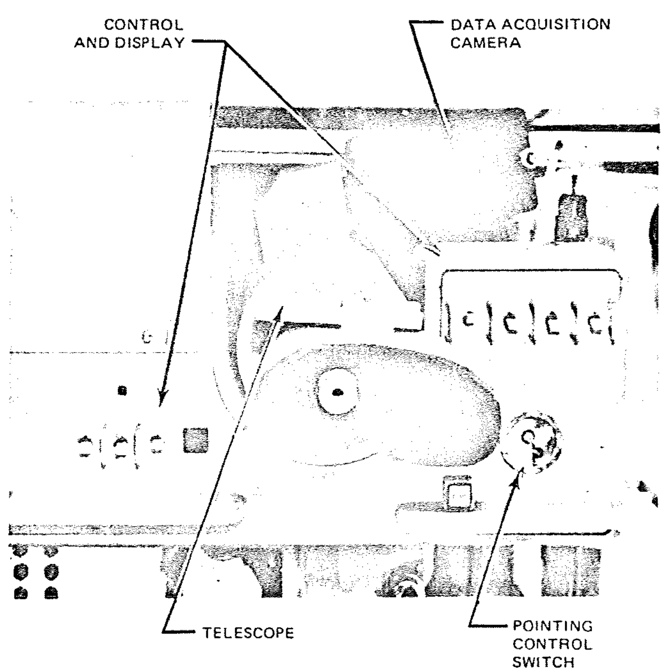


S191 INFRARED SPECTROMETER

PURPOSE: Provide data for evaluation of specific regions of visible and Infrared Spectrometer spectrum for Earth resources sensing and for quantitative evaluation of the effects of atmospheric attenuation.

SIGNIFICANCE: Scientists in various disciplines will be able to evaluate the utility of remote infrared spectrometer sensing from space.

EQUIPMENT USED:
- Infrared Spectrometer
- Earth Resources Experiment Package Support Equipment

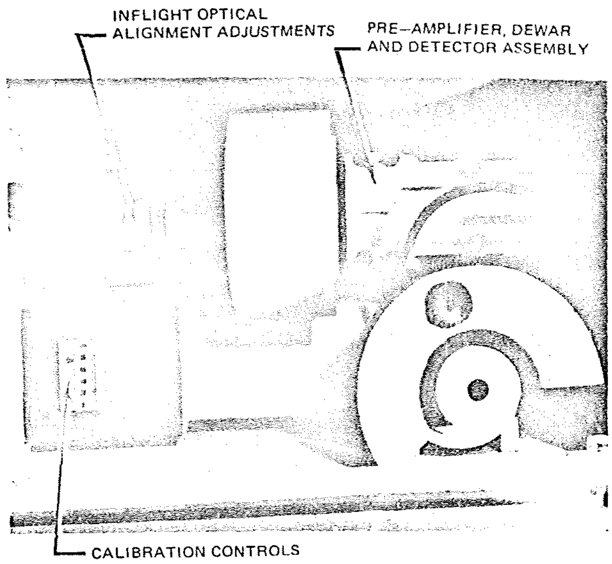


S192 MULTISPECTRAL SCANNER

PURPOSE: Provide, in registration, quantitative line-scan imagery data of radiation reflected and emitted by selected test sites in the visible, near-infrared and thermal infrared regions of the spectrum.

SIGNIFICANCE: Evaluate usefulness of spacecraft multispectral data for crop identification, vegetation mapping, soil moisture measurements, identification of contaminated areas in large bodies of water, and surface temperature mapping.

EQUIPMENT USED:
- Multispectral Scanner
- Earth Resources Experiment Package Support Equipment

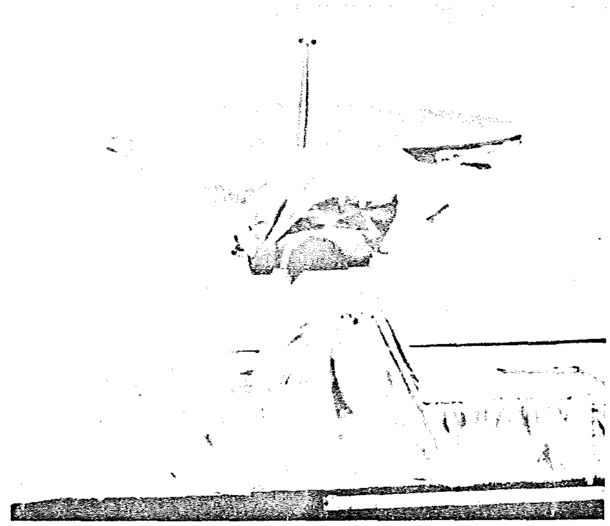


S193 MICROWAVE RADIOMETER/ SCATTEROMETER AND ALTIMETER

PURPOSE: Provide simultaneous measurement of differential back scattering cross-section and passive microwave emissivity of land and ocean areas; obtain altimetry data relating sensor response to actual oceanic state.

SIGNIFICANCE: Successful application will provide information relative to seasonal changes in snow cover and border between frozen and unfrozen ground, gross vegetation regions and seasonal changes, flooding, feasibility of measuring soil types and texture, heat output of metropolitan areas, areas of lake and sea ice, and ocean surface characteristics.

EQUIPMENT USED:
- Microwave Radiometer/Scatterometer/Altimeter
- Earth Resources Experiment Package Support Equipment

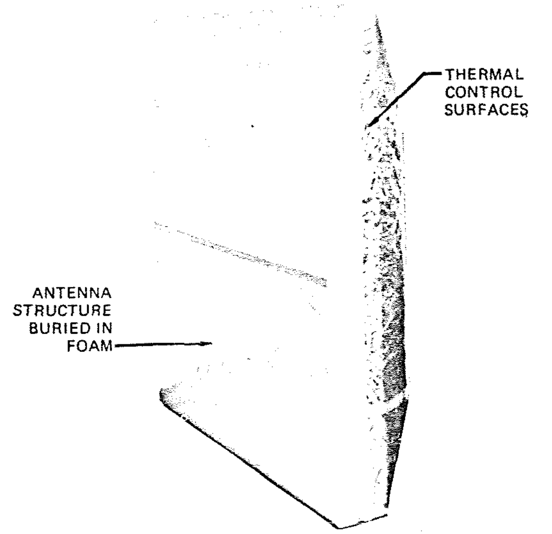


S194 L-BAND RADIOMETER

PURPOSE: Measure and map brightness temperature of the terrestrial surface to a high degree of accuracy.

SIGNIFICANCE: Measurements of the brightness temperature of the Earth's surface will supplement the S193 experiment. Effects of cloud cover on radiometric measurements can be determined by taking measurements at both S193 and S194 frequencies (13.9 GHz and 1.43 GHz).

EQUIPMENT USED:
- L Band Radiometer
- Earth Resources Experiment Package Support Equipment



4.2.2 Apollo Telescope Mount Solar Observations

Experiment No.	Title
S052	White Light Coronagraph
S054	X-Ray Spectrographic Telescope
S055A	UV Scanning Polychromator/Spectroheliometer
S056	X-Ray Telescope
S082A	XUV Coronal Spectroheliograph
S082B	UV Spectrograph

The Apollo Telescope Mount has been designed and developed to house and support manned telescopes for studying the Sun. It achieves the operational capability and flexibility of the more advanced instruments in ground-based observatories while extending their range to wavelengths below 3,000Å observable only above the Earth's atmosphere.

The investigation of many solar phenonema will require complementary observations with several instruments. For example, a better model of the temperature and constituent profiles from the photosphere to the corona will require observations with high spectral and spatial resolution at many different wavelengths. These models are essential to an understanding of the energy transport between the relatively cool photosphere and the million-degree corona. Combined efforts are equally important to an understanding of the development and energy producing mechanisms in a flare and to establishing the relationship between coronal structure and the solar wind in interplanetary space.

In terms of these fundamental problems, the objectives of the Apollo Telescope Mount experiments are: (1) acquire high-resolution observations of the Sun's structure and behavior from above the Earth's atmosphere, (2) utilize man's ability for rapid response to transients, pointing, and tracking tasks, to selectively operate the various experiments in many different modes, circumvent failure, and retrieve photographic film by extravehicular activities, and (3) obtain engineering and technological data needed for development of advanced astronomical systems.

The Apollo Telescope Mount contains telescopes covering wavelengths ranging from 2Å to 6,500Å. Two targeting telescopes operate in the H-alpha wavelength (6,563Å) and primarily display the solar image to the astronaut for solar event monitoring and target reference. X-ray grazing incidence telescopes record on film the X-ray image of the Sun. Two ultraviolet spectrographic instruments, one covering the entire solar disc and the other recording spectra from a 3 by 60 arc-second area, are film instruments. These are complemented by an ultraviolet spectroheliograph recording its data by photoelectric means.

A white light coronagraph with external occultation of 1.5 solar radii complete the instrument package. Six of the instruments employ photographic film as the data storage medium. Access to the film magazines requires extravehicular activity to retrieve and resupply film during the mission.

An Apollo Telescope Mount control and display panel located in the Multiple Docking Adapter contains all the displays and controls for monitoring and operating. A key element of this panel is the video display of the boresighted television camera associated with several of the scientific instruments. Images from five different instruments within the experiment package are provided to point the optical axes of the telescopes to areas of interest on the solar disc, or to correct for pointing errors or drifts that occur during operation. Other information displayed concerns the intensity of solar activity and status of the control system and other subsystems of the Apollo Telescope Mount.

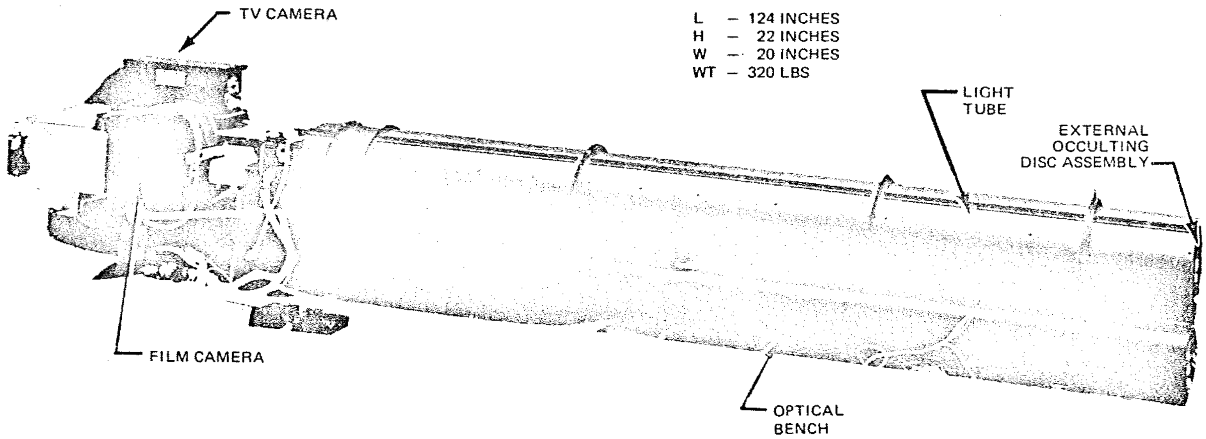
The crew performs two basic functions relative to the experiments. The first function involves operation of the experiments as a package by the control and display panel. In this function, the crewmen serve as onboard observational scientists, equipment operators, and troubleshooting technicians. The second function involves the manual and physical servicing of the instruments by removal and replacement of film magazines. Exposed film stock is returned to Earth in the Command Module at the end of each mission.

S052 WHITE LIGHT CORONAGRAPH

PURPOSE: Obtain high angular resolution photographs of the corona from 1.5 to 6 solar radii to study brightness, form, size, polarization and evolution of coronal activity, and its correlation with surface events.

SIGNIFICANCE: Greatly increases understanding of solar physics through the advantage of continuous coronal observations, providing ability to develop a three-dimensional structure of coronal forms and their connection with surface features over the 27-day solar rotation period.

EQUIPMENT USED:
- White Light Coronagraph

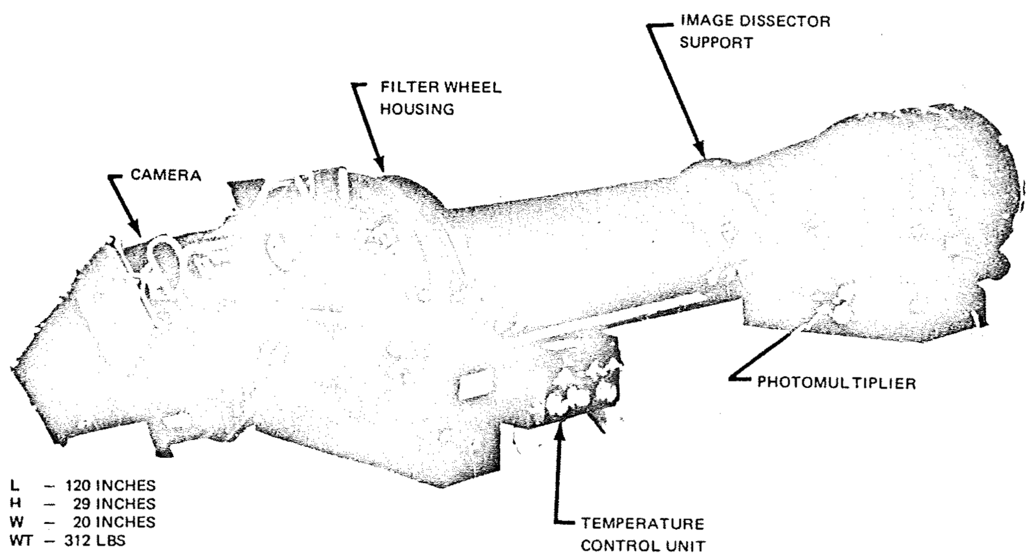


S054 X-RAY SPECTROGRAPHIC TELESCOPE

PURPOSE: Obtain x-ray emissions of flares with spatial resolution of 2 arc-seconds, and simultaneously record spectrally dispersed emissions over the range of 2 to 60 Å with resolution of a fraction of an angstrom; follow the evolution of both the spatial image and the spectrum throughout the lifetime of a flare; follow the evolution of nonflaring active regions; and correlate coronal x-ray structure with surface events.

SIGNIFICANCE: Increase understanding of solar physics through possible detection of emission lines in addition to the continuous spectrum, and correlation of measurements with ground based and H-alpha measurements to construct a comprehensive picture of solar flare phenomena.

EQUIPMENT USED:
- X-Ray Spectrographic Telescope



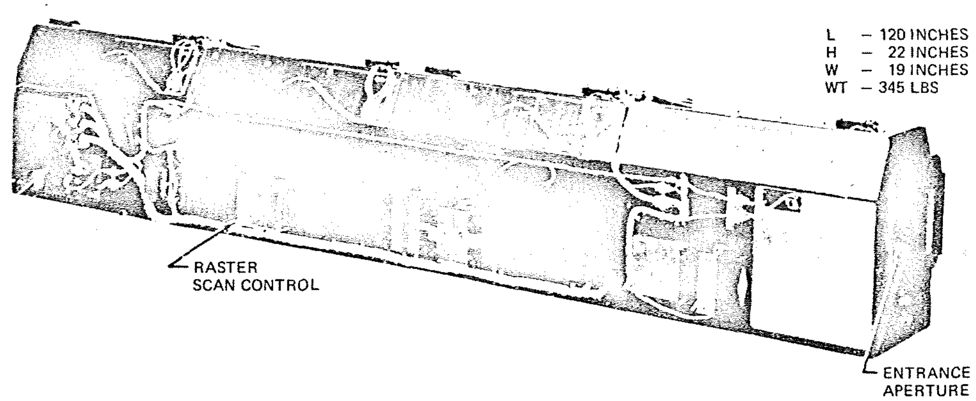
S055A UV SCANNING POLYCHROMATOR/SPECTROHELIOMETER

PURPOSE: Photometric ultraviolet observations of the solar atmosphere near or above active regions on the solar disc in the wavelength range of 300 to 1,350Å. The data obtained will yield information about the composition, structure, and processes involved in both quiet and active solar phenomena.

SIGNIFICANCE: Increase understanding of solar physics and photoelectrically record high resolution solar images in seven spectral lines simultaneously; study structure of solar atmosphere.

EQUIPMENT USED:

- UV Scanning Polychromator/Spectroheliometer



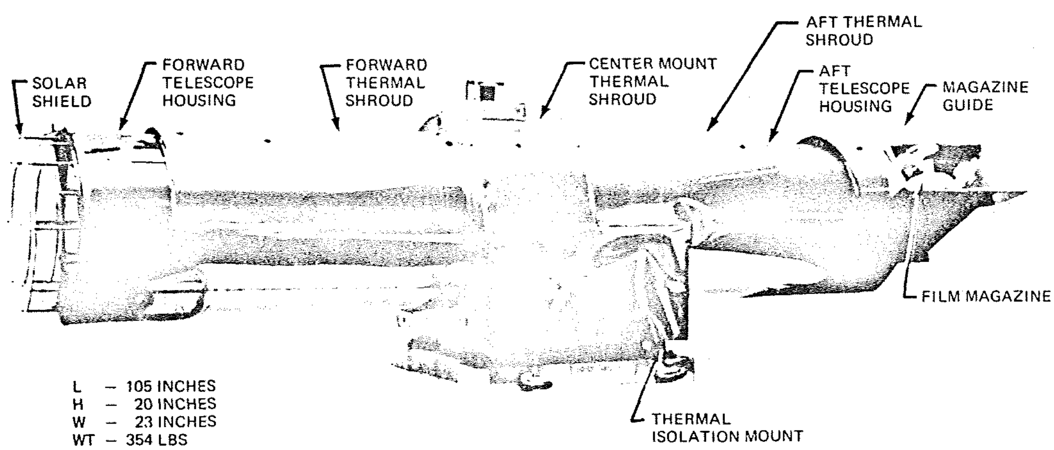
S056 X-RAY TELESCOPE

PURPOSE: Photograph active solar regions in the 6 to 33Å wavelengths during both active and quiescent periods, with high spatial and temporal resolution and low spectral resolution; monitor and record total solar x-ray flux measurements in the 2 to 8Å and 8 to 20Å spectral regions with proportional counters.

SIGNIFICANCE: Increase understanding of solar physics in the x-ray spectral region, uninhibited by the atmosphere.

EQUIPMENT USED:

- X-Ray Telescope



S082A XUV CORONAL SPECTROHELIOGRAPH

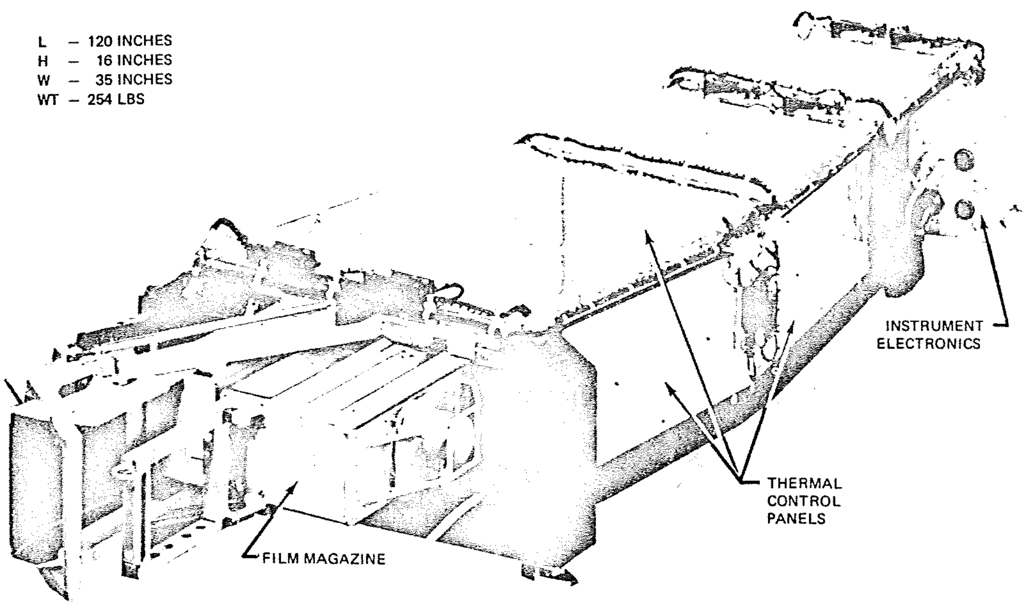
PURPOSE: Designed to photographically record coronal images of the Sun in the extreme ultraviolet wavelengths between 150 and 625Å.

SIGNIFICANCE: Increased understanding of solar physics.

EQUIPMENT USED:

- XUV Coronal Spectroheliograph

L – 120 INCHES
H – 16 INCHES
W – 35 INCHES
WT – 254 LBS



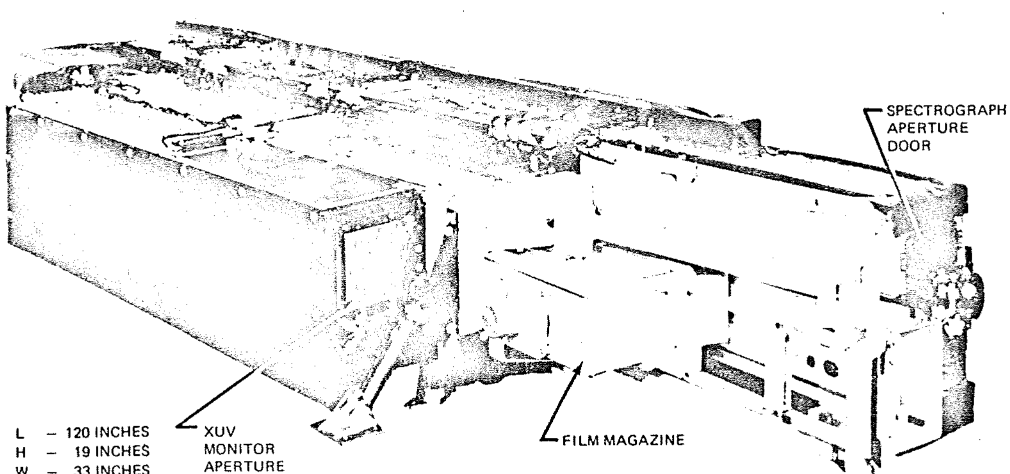
S082B UV SPECTROGRAPH

PURPOSE: The spectrograph will be used to photographically record line spectra of small selected areas on and off the solar disc and across the limb in two wavelength bands, 970 to 1,970Å or 1,940 to 3,940Å. The XUV monitor will be used for observing a video image of the full solar disc in the wavelength band from 170 to 550Å.

SIGNIFICANCE: Increased understanding of solar physics; ability to obtain high spatial resolution to permit recording of spectra from discrete areas of activity in the chromosphere.

EQUIPMENT USED:

- UV Spectrograph



L – 120 INCHES
H – 19 INCHES
W – 33 INCHES
WT – 421 LBS

4.2.3 Scientific Experiments

Experiment No.	Title
S009	Nuclear Emulsion
S019	UV Stellar Astronomy
S020	UV/X-Ray Solar Photography
S063	UV Airglow-Horizon Photography
S073	Gegenschein/Zodiacal Light
S149	Particle Collection
S150	Galactic X-Ray Mapping
S183	Ultraviolet Panorama

The science experiments carried by Skylab will take advantage of its position above the Earth's atmosphere and the zero-g environment. These experiments and their associated instruments either obtain data in spectral regions where the atmosphere absorbs strongly, e.g., ultraviolet and x-ray region, or measure primary cosmic rays, the composition of which changes if they interact with the atmosphere. The science experiments will provide data for: (1) cosmic ray physics, (2) ultraviolet and x-ray solar astronomy, (3) aeronomy/magnetospheric physics, and (4) meteoretics. The astronomy experiments complement those experiments performed by the Apollo Telescope Mount instruments and include mapping to obtain information in the relatively new field of x-ray galactic astronomy. The aeronomy experiments will observe the air-glow layer above the Earth's atmosphere and extend similar measurements performed on Gemini. Micrometeorite material will be collected.

S009 NUCLEAR EMULSION

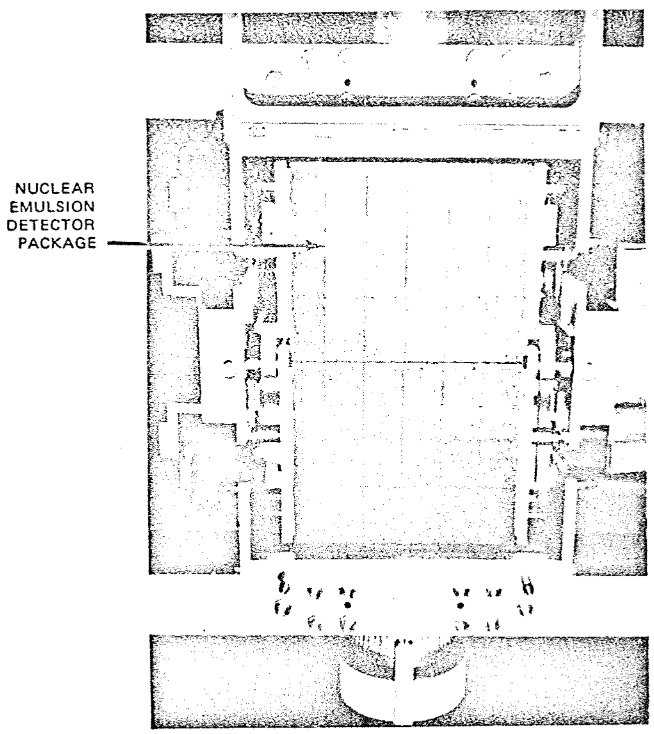
PURPOSE: Study charge spectrum of primary cosmic rays with emphasis on heavy nuclei.

SIGNIFICANCE: Acquire data before cosmic rays interact with Earth's atmosphere. Will yield information contributing to basic understanding of cosmic ray physics.

EQUIPMENT USED:

- Nuclear Emulsion Detector Package

CREW INVOLVEMENT: One crewman removes the experiment package and deploys the emulsion stacks in the hard mounted experiment housing in the Multiple Docking Adapter. The stacks are returned to Earth via the Command Module after the end of the first manned period.



S019 UV STELLAR ASTRONOMY

PURPOSE: Study ultraviolet line spectra and spectral energy distribution of early-type stars (low dispersion spectra) and obtain ultraviolet spectra in large number of Milky Way fields (high dispersion spectra).

SIGNIFICANCE: Experiment will increase understanding of physics of star formation, galactic structure, and interstellar medium.

EQUIPMENT USED:

- Optical and Film Canister and Stowage Container
- Articulated Mirror System

CREW INVOLVEMENT: One crewman is required to setup the experiment in the Scientific Airlock and photograph 50 star fields with 3 exposures each during periods when the Skylab is in the dark side of the orbit.

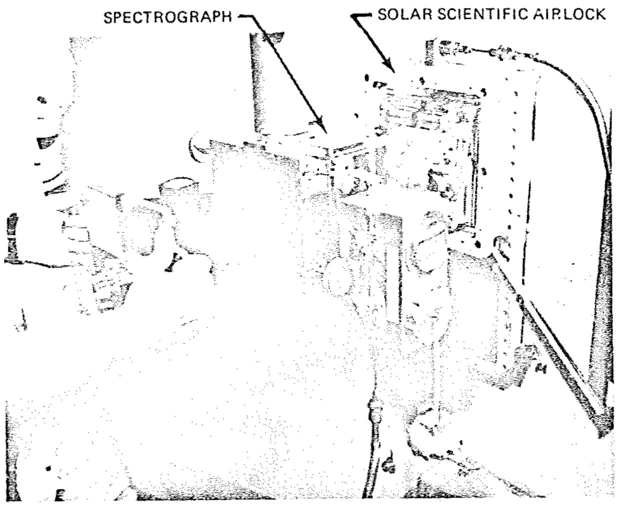
S020 UV X-RAY SOLAR PHOTOGRAPHY

PURPOSE: Photograph x-ray and extreme ultraviolet spectrum of Sun in wavelength region from 10 to 200Å.

SIGNIFICANCE: Increase understanding of solar physics; practical application in radio communications, and research for nuclear production.

EQUIPMENT USED:
- Spectrograph

CREW INVOLVEMENT: Two crewmen are involved in the setup and checkout of the experiment in the Scientific Airlock. When notified that a solar flare may occur, the crewmen point the equipment at the solar disc and obtain exposures over a period of approximately 2 hours and 45 minutes.



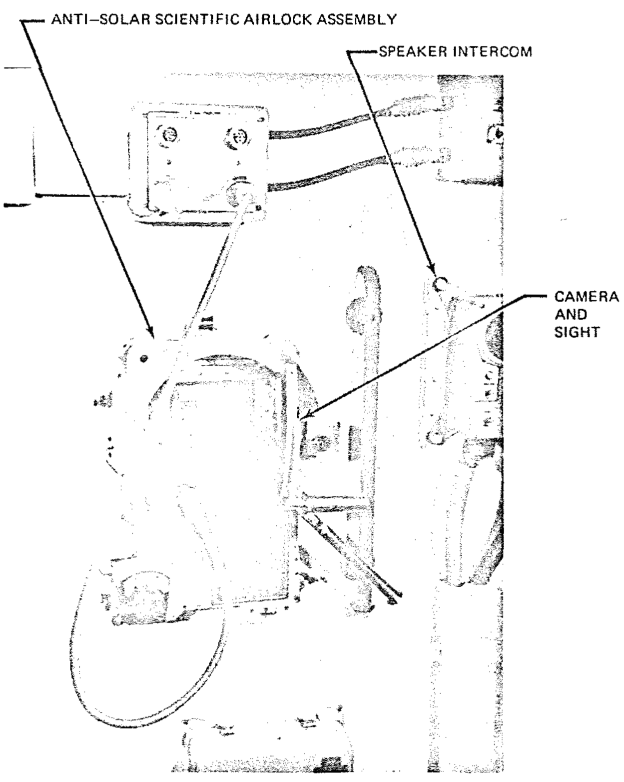
S063 UV AIRGLOW HORIZON PHOTOGRAPHY

PURPOSE: Photograph in the visible and UV spectra the Earth's ozone layers and twilight airglow.

SIGNIFICANCE: Measurements will yield altitudes and intensities of the oxygen, nitrogen, and UV airglow layers. Knowledge of upper atmospheric airglow and movements will be derived.

EQUIPMENT USED:
- UV Airglow Horizon Cameras

CREW INVOLVEMENT: One crewman attaches the cameras to the Scientific Airlock and wardroom windows, makes appropriate exposure time and shutter settings, and performs exposures during approximately 28 orbits of the mission.



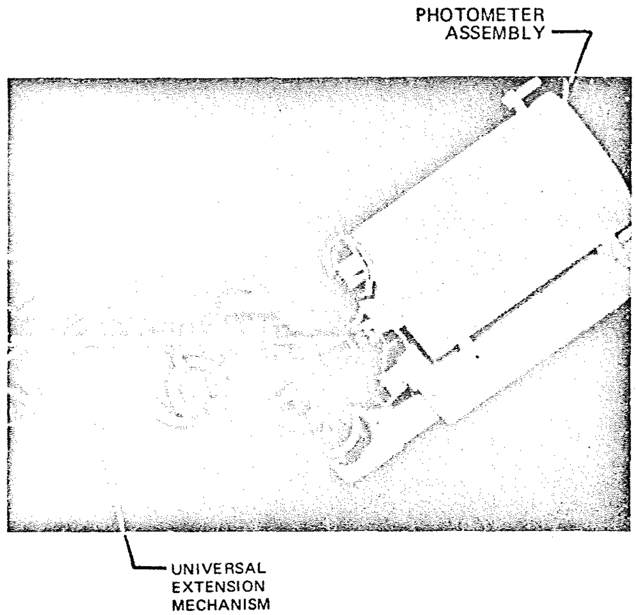
S073 GEGENSCHEIN/ZODIACAL LIGHT

PURPOSE: Measure the surface brightness and polarization of the night glow over a large portion of the celestial sphere and determine the extent and nature of the spacecraft corona during daylight.

SIGNIFICANCE: The night time experiment will portray astronomical sources without confusion from the 90 km airglow layer in ground observations. Spacecraft corona measurements will enhance definition of the optical environment for day time astronomy from spacecraft.

EQUIPMENT USED:
- T027/S073 Photometer System and Film Magazine
- Universal Extension Mechanism

CREW INVOLVEMENT: One crewman is required to set up the experiment in the Scientific Airlock and deploy photometer assembly. An automatic programmer minimizes the crew participation. Film is retrieved for Earth return.



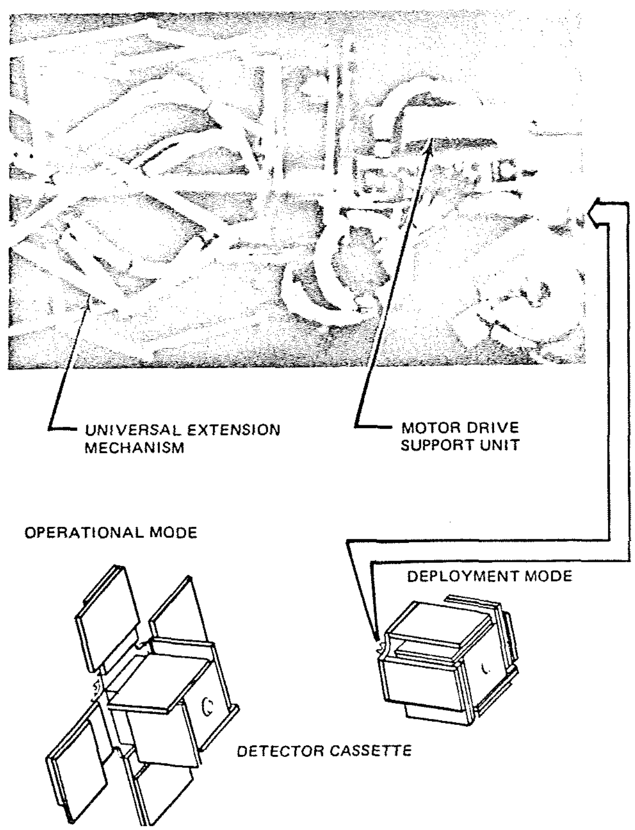
S149 PARTICLE COLLECTION

PURPOSE: Determine mass distribution, composition, and morphology of micrometeorites in near-Earth space.

SIGNIFICANCE: Surface erosion data will determine design requirements for future spacecraft. Increase knowledge of space biology as secondary objective when cassette contamination is analyzed.

EQUIPMENT USED:
- Detector Cassette and Motor Drive Support Unit
- Universal Extension Mechanism

CREW INVOLVEMENT: One crewman is required to set up and deploy the detector assembly through the Scientific Airlock. The experiment is activated from the ground although the crewman can manually control the experiment, if required.



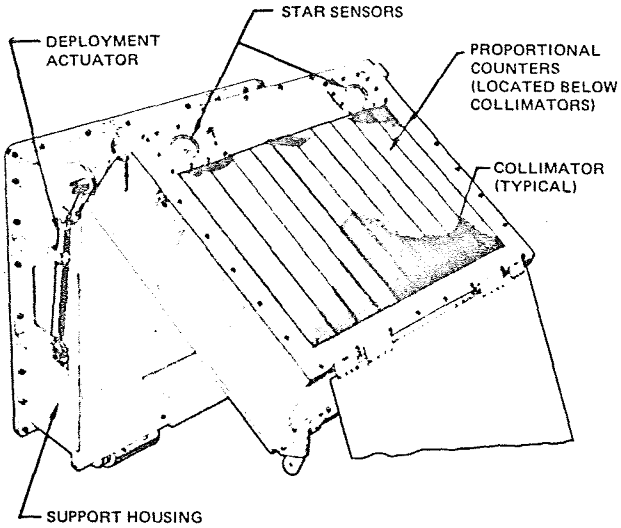
S150 GALACTIC X-RAY MAPPING (B)

PURPOSE: Survey a portion of celestial sphere for galactic x-ray sources in the 0.2 KEV to 10 KEV energy range.

SIGNIFICANCE: Detailed measurements in x-ray range of 200 EV to 10 KEV will help determine emission mechanisms, distance to sources, and nature of interstellar medium. Data will lead to better understanding of complex appearance of sky at x-ray wavelengths and assist in design of more sensitive detectors.

EQUIPMENT USED:
- X-Ray Mapping Sensor Package

CREW INVOLVEMENT: None.



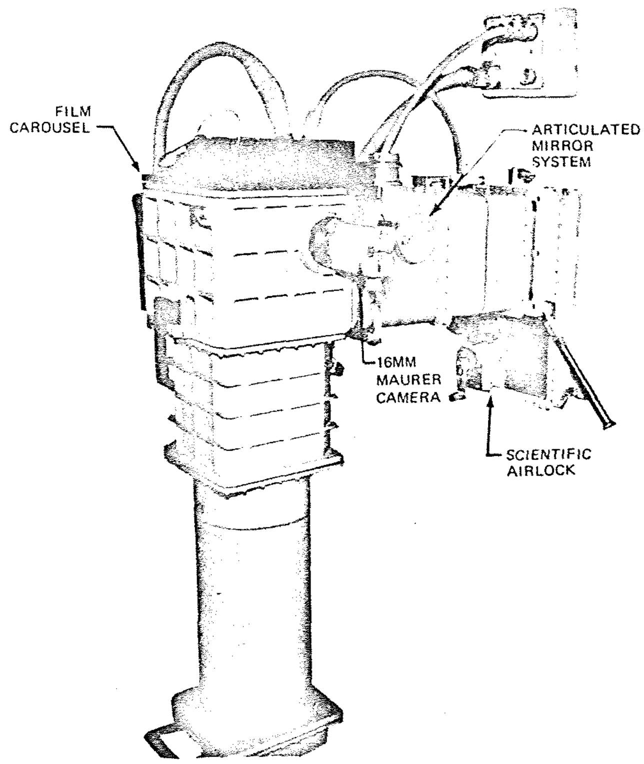
S183 ULTRAVIOLET PANORAMA

PURPOSE: Obtain wide field of view photographs of individual stars and extended star fields in the ultraviolet.

SIGNIFICANCE: Obtain color indices in three spectral bands of selected stars not observable from the ground, stellar clouds, and galaxies. Will improve knowledge of early type stars and star life processes.

EQUIPMENT USED:
- Telescope/Spectrograph/Camera Assembly
- Articulated Mirror System

CREW INVOLVEMENT: One crewman sets up the experiment in the Scientific Airlock. Using a finder telescope and mirror controls, the desired area of the sky will be located prior to the initiation of the exposure sequence.



4.2.4 Life Science Investigations

Life science investigations include medical investigations and biology experiments.

4.2.4.1 Medical Investigations

Experiment No.	Title
M071	Mineral Balance
M073	Bioassay of Body Fluids
M074	Specimen Mass Measurement
M092	In-Flight Lower Body Negative Pressure
M093	Vectorcardiogram
M112	Man's Immunity in Vitro Aspects
M113	Blood Volume Red Cell Life Span
M114	Red Blood Cell Metabolism
M115	Special Hematologic Effects
M131	Human Vestibular Function
M133	Sleep Monitoring
M151	Time and Motion Study
M171	Metabolic Activity
M172	Body Mass Measurement
M487	Habitability and Crew Quarters (Reference Only – Listed under Operations Experiments)

The following pre- and post-flight experiments are not performed in orbit but are part of the medical investigations.

Experiment No.	Title
M078	Bone Mineral Measurement
M111	Cytogenic Studies of Blood

4.2.4.2 Biology Experiments

Experiment No.	Title
S015	Effect of Zero Gravity on Single Human Cells*
S071	Circadian Rhythm of Pocket Mice*
S072	Circadian Rhythm of Vinegar Gnats*

Skylab offers the opportunity for gathering data to extend the experience gained during the Gemini and Apollo programs by providing physiological information on the effects of weightlessness on body functions and living organisms.

All crewmen are involved in the medical investigations. The dual roles assumed by each of the crew are: (1) being an experimental subject and (2)

**This experiment is integrated by the Manned Spacecraft Center.*

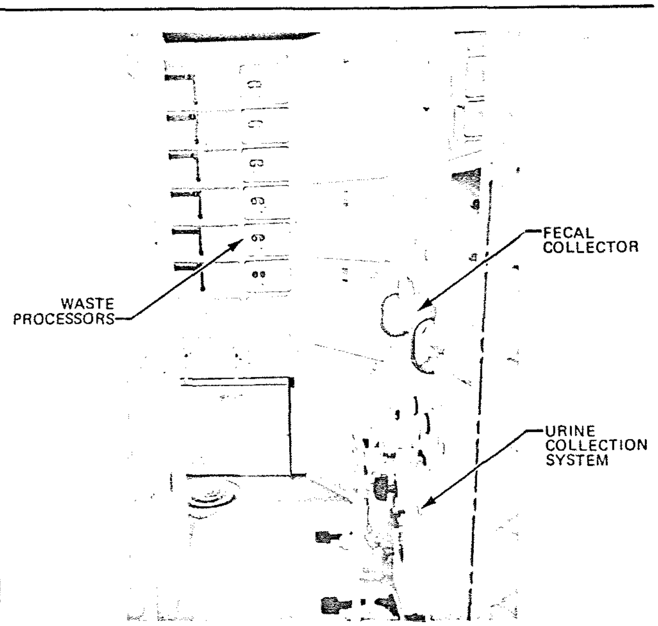
being an experiment conductor. The first role permits the physiological and performance data to be extended across several subjects. Typical tasks involve instrumented ergometer exercises, rotating litter chair tests, and body mass determination. The second role involves experiment support activities such as personal observations, equipment operation, photography, safety monitoring, and sample preparation and preservation. The flight schedule provides these data sufficiently early to provide planning data for future manned systems. The three biology experiments will determine the effects of the space environment on living organisms.

M071/073 MINERAL BALANCE/BIOASSAY OF BODY FLUIDS

PURPOSE: Define and conduct quantitative assessment of body gains and losses of biochemical constituents, particularly water, calcium, and nitrogen during space flight. Assess metabolic changes in man as a result of the space flight environment through analysis of hormonal, fluid, and electrolyte parameters.

SIGNIFICANCE: Provide information to determine and understand the time course and level of the body's metabolism and mineral balance in the absence of Earth gravity for prolonged periods of time.

EQUIPMENT USED:
- Body Mass Measurement Device
- In-Flight Blood Collection System (IBCS)
- Specimen Mass Measurement Device
- Speaker Intercom
- Waste Management System



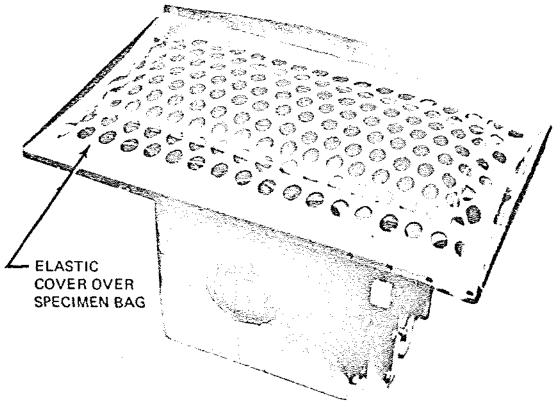
M074 SPECIMEN MASS MEASUREMENT

PURPOSE: Demonstrate mass measurement without gravity; validate theoretical behaviors of the device; support biomedical experiments requiring mass determination.

SIGNIFICANCE: Demonstrate feasibility of mass measurement in space environment. Support biomedical experiments requiring specimen weight data (M071/M073 and M171).

EQUIPMENT USED:

- Specimen Mass Measurement Device
- Waste Management System
- Speaker Intercom



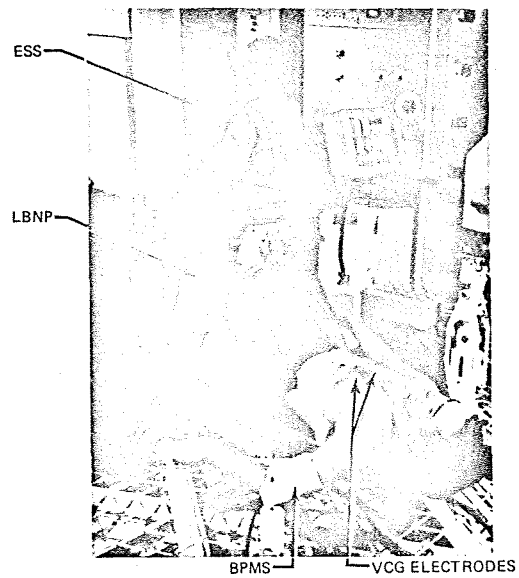
M092 IN-FLIGHT LOWER BODY NEGATIVE PRESSURE

PURPOSE: Evaluate magnitude and time course of cardiovascular accommodation during long duration spaceflight.

SIGNIFICANCE: Provide initial capability to assess in-flight cardiovascular changes observed to date on the basis of pre- and post-flight studies. Will contribute to the definition of countermeasures, if required.

EQUIPMENT USED:

- Lower Body Negative Pressure Device (LBNP)
- Vectorcardiogram System (VCG)
- Blood Pressure Measurement System (BPMS)
- Leg Volume Measurement System
- Body Temperature Measurement System
- Experiment Support System (ESS)



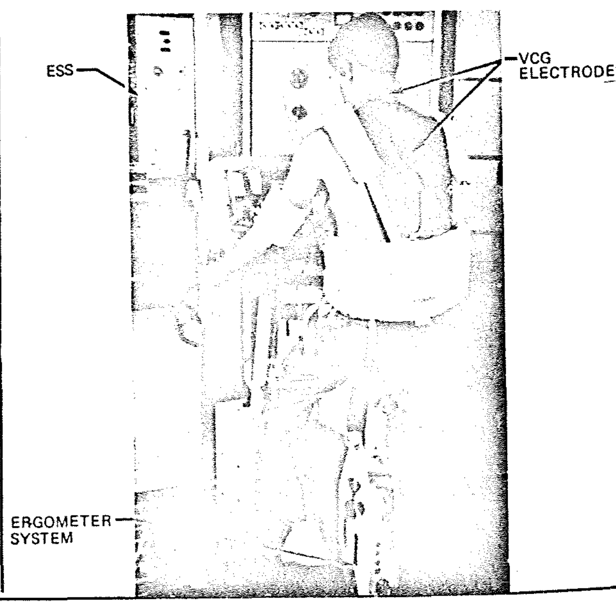
M093 VECTORCARDIOGRAM

PURPOSE: Measure electrical activity of the heart during weightlessness and immediately pre- and post-flight to obtain precise quantification of changes which occur.

SIGNIFICANCE: Changes in the cardiovascular system during space flight could degrade the cardiovascular functions during and after space flight. Knowledge gained to predict body changes, devise countermeasures and anticipate effects of even longer periods of space flight.

EQUIPMENT USED:

- Vectorcardiogram System (VCG)
- Ergometer System
- Experiment Support System (ESS)
- Speaker Intercom
- Photographic Equipment

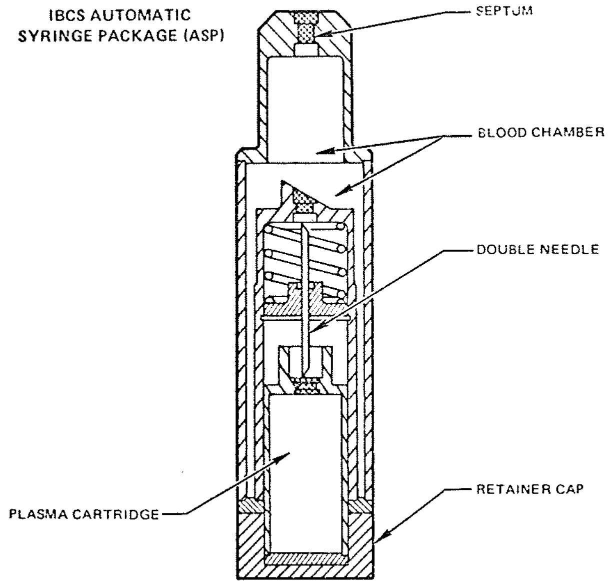


M112 MAN'S IMMUNITY IN VITRO ASPECTS

PURPOSE: Assay humoral and cellular irregularities in crewmen as a result of spaceflight.

SIGNIFICANCE: While this experiment is primarily involved with pre- and post-flight evaluations, blood samples taken during the mission will fill the gap between the pre- and post-flight data.

EQUIPMENT USED:
- In-Flight Blood Collection System (IBCS)
- Waste Management System

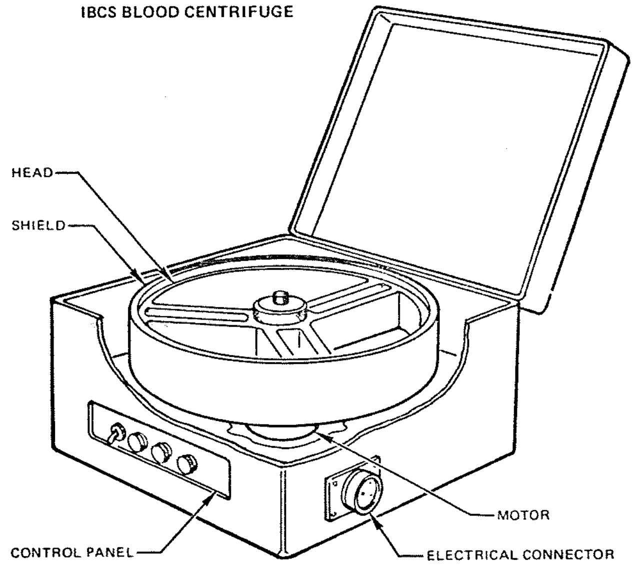


M113 BLOOD VOLUME AND RED CELL LIFE SPAN

PURPOSE: Determine changes in red cell mass, red cell production, red cell survival, and plasma volume in crewmen as a result of spaceflight.

SIGNIFICANCE: While this experiment is primarily involved with pre- and post-flight evaluations, blood samples taken during the mission will fill the gap between the pre- and post-flight data.

EQUIPMENT USED:
- In-Flight Blood Collection System (IBCS)
- Waste Management System



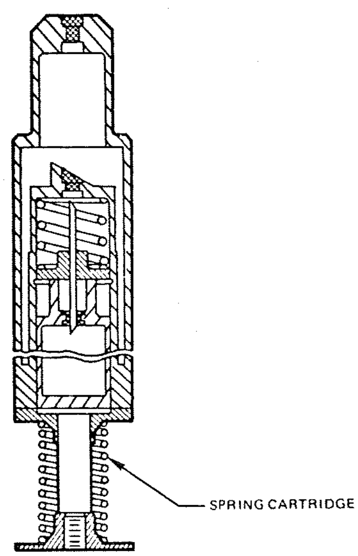
M114 RED BLOOD CELL METABOLISM

PURPOSE: Determine any changes in red cell metabolism and in membrane integrity in crewmen as a result of spaceflight.

SIGNIFICANCE: While this experiment is primarily involved with pre- and post-flight evaluations, blood samples taken during the mission will fill the gap between the pre- and post-flight data.

EQUIPMENT USED:
- In-Flight Blood Collection System (IBCM)
- Waste Management System

IBCS AUTOMATIC SYRINGE PACKAGE ON SPRING CARTRIDGE

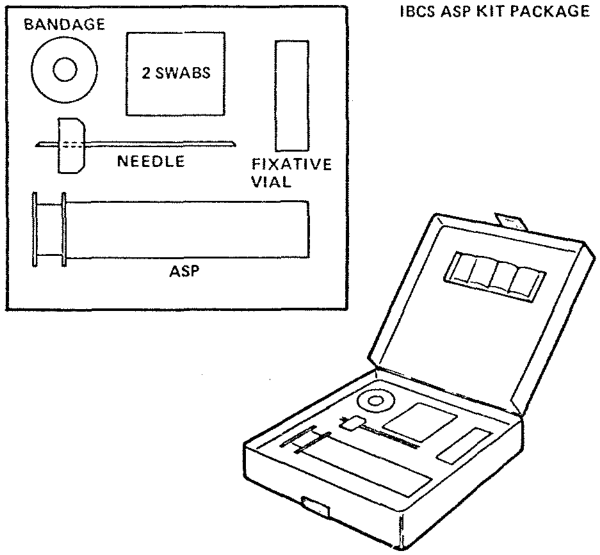


M115 SPECIAL HEMATOLOGIC EFFECTS

PURPOSE: Supply etiologic data to describe several physiological parameters involved in the nemolytic phenomena observed in crewmen as a result of spaceflight.

SIGNIFICANCE: While this experiment is primarily involved with pre- and post-flight evaluations, blood samples taken during the mission will fill the gap between the pre- and post-flight data.

EQUIPMENT USED:
- In-Flight Blood Collection System (IBCS)
- Waste Management System

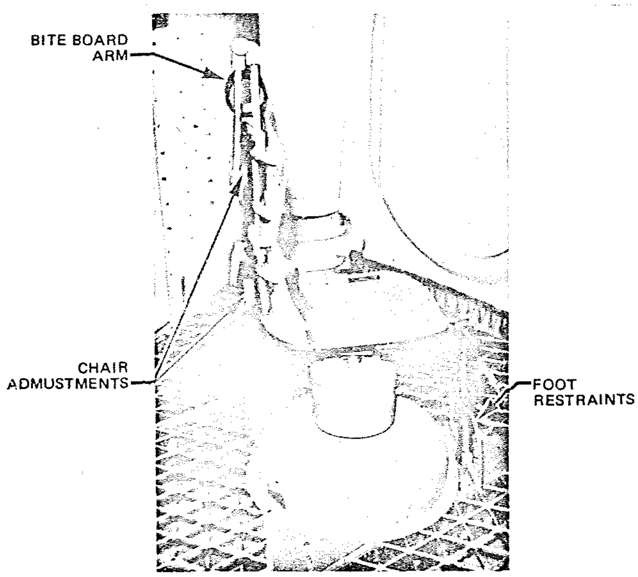


M131 HUMAN VESTIBULAR FUNCTION

PURPOSE: Determine if there are significant effects produced by weightlessness on the vestibular (otolith and semicircular canal) function and its relationship to spatial orientation.

SIGNIFICANCE: Understanding is required of any effects on the central nervous system, the coordinating mechanism for human performance and behavior, to be assured of man's continued effective participation in scientific investigations in space.

EQUIPMENT USED:
- Rotating Litter Chair and Control Console
- Otolith Test Goggles and Accessories
- Speaker Intercom

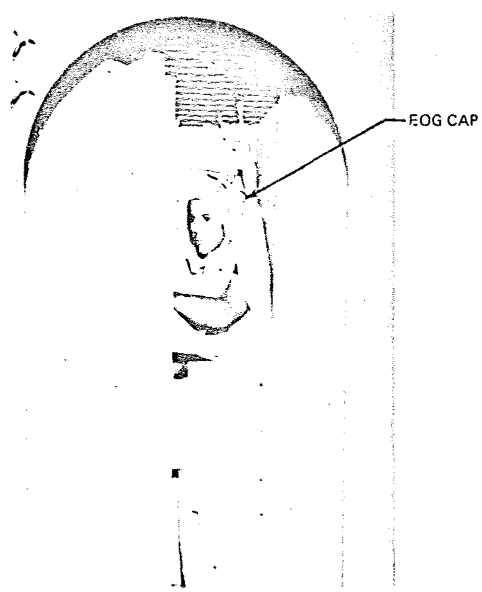


M133 SLEEP MONITORING

PURPOSE: Evaluate quantity and quality of sleep during prolonged space flight.

SIGNIFICANCE: Understanding is required of the depth and amount of sleep of crewmen in space. Information will complement other central nervous system measurements and contribute to planning of duty-rest schedule for future missions.

EQUIPMENT USED:
- Electroencephalograph/Electro-oculograph Cap Assembly and Accessories (EOG)
- Speaker Intercom

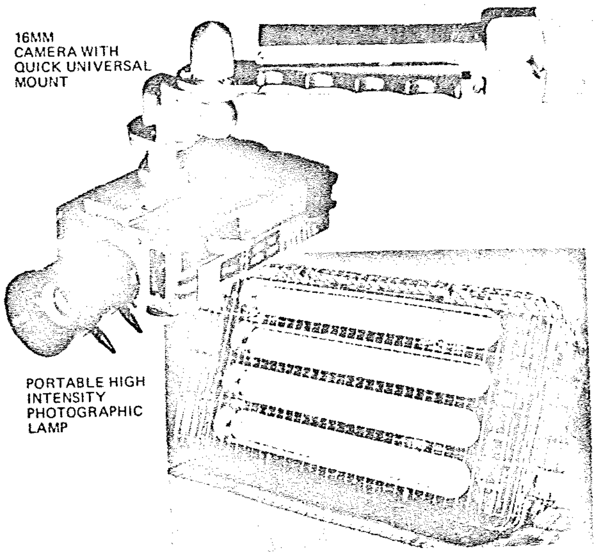


M151 TIME AND MOTION STUDY

PURPOSE: Evaluate the relative consistency between ground-based and in-flight task performance.

SIGNIFICANCE: Data will provide insight into the nature of work in zero gravity and will aid in establishing and quantifying some of the advantages and disadvantages of zero gravity.

EQUIPMENT USED:
- Photographic Equipment
- Speaker Intercom
- High Intensity Photographic Lamps

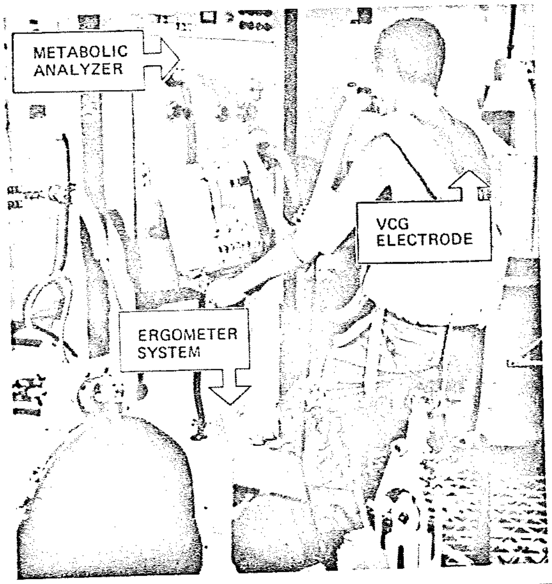


M171 METABOLIC ACTIVITY

PURPOSE: Evaluation of man's metabolic effectiveness and the cost of work in the space environment.

SIGNIFICANCE: Provide information for planning of long duration space missions such as: physiological limitations to work response or capacity, task planning, design of environmental control system, and logistics of food and expendables.

EQUIPMENT USED:
- Metabolic Analyzer
- Ergometer System
- Blood Pressure Measurement System
- Body Temperature Measurement System
- Vectorcardiogram System (VCG)
- Experiment Support System
- Speaker Intercom
- Photographic Equipment

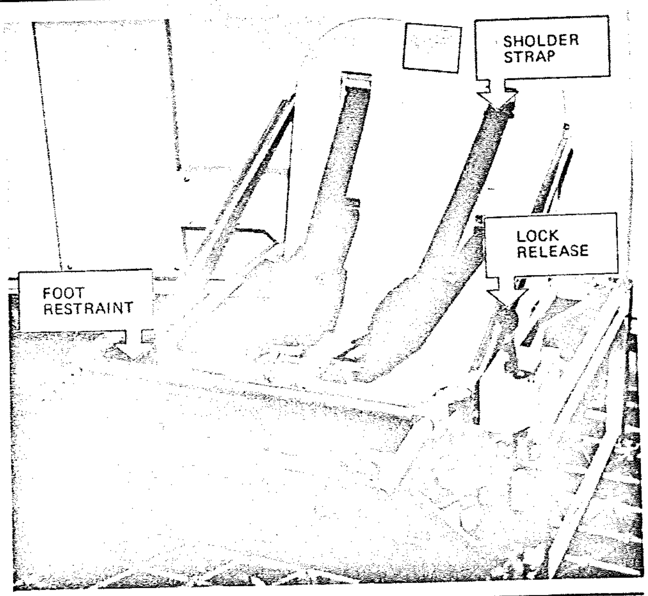


M172 BODY MASS MEASUREMENT

PURPOSE: Validate the design and use of body mass measurement system; determine the time course and magnitude of body weight changes of crew members.

SIGNIFICANCE: Demonstrates feasibility of body mass measurement in space environment. Provides complementary data to medical experiments by acquiring daily body weight data on crewmen.

EQUIPMENT USED:
- Body Mass Measurement Device and Accessories



S015 EFFECTS OF ZERO GRAVITY ON SINGLE HUMAN CELLS*

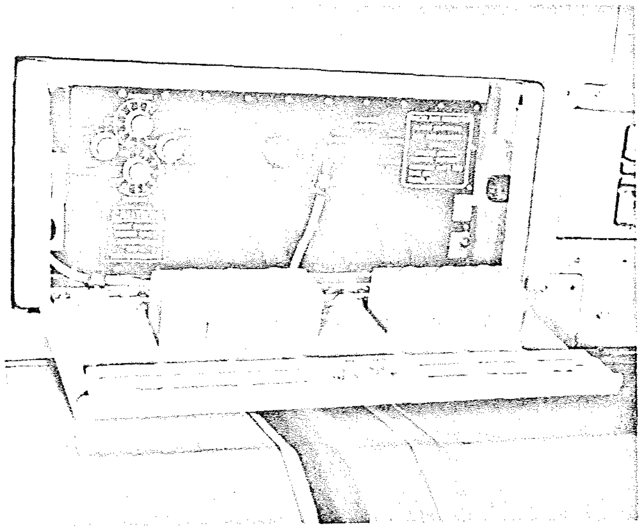
PURPOSE: Determine the effects and behavior of living human cells (in a tissue culture) in zero gravity.

SIGNIFICANCE: This experiment will study the influence of zero gravity on living human cells and tissue culture. It will address the question of whether the absence of gravity has a significant effect on isolated human cells. The investigation will consist of recording the morphologic and physiologic functions of the cells and biochemical and structural status of the cells at zero gravity.

EQUIPMENT USED:
- Microscope Camera Subsystem
- Biopack Subsystem

CREW INVOLVEMENT: One crewman checks the indicator lights for proper operation and activates switches on the fourth and tenth day of the mission. The apparatus and specimens are returned to Earth via the Command Module after the end of the mission.

**This experiment is integrated by the Manned Spacecraft Center.*



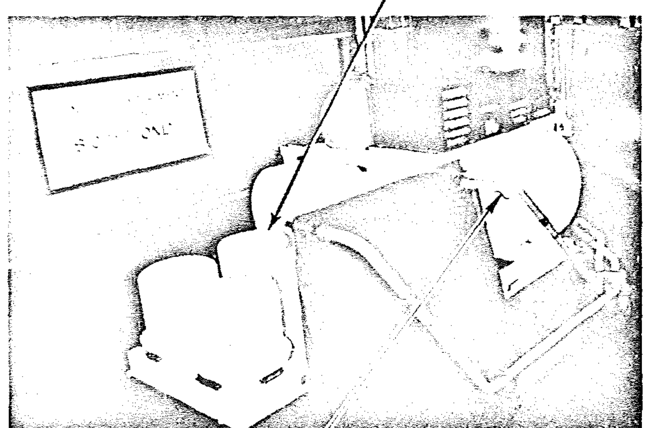
S071/S072 CIRCADIAN RHYTHM, POCKET MICE AND VINEGAR GNATS

PURPOSE: Study the circadian rhythms of body temperatures and activity in pocket mice and vinegar gnats in an environment of constant temperature, pressure, and total darkness; study the rhythms in the absence of geophysical variables (zero gravity) within a 24-hour period.

SIGNIFICANCE: Investigate both the stability of a fundamental biological process in space and yield data which may be extrapolated to provide practical import to prolonged manned space missions. Variance among the circadian rhythms observed in flight, and rhythms observed in ground control groups will be determined.

EQUIPMENT USED:
- S071/S072 Experiment Assembly (animal enclosure, environmental control system, electronics, pupae compartments, data system, cooling system)

CREW INVOLVEMENT: Participation is limited to one crewman who removes power from the experiment upon completion.



4.2.5 Technology Experiments

Experiment No.	Title
D008	Radiation in Spacecraft*
D024B	Thermal Control Coatings
M415	Thermal Control Coatings
M479	Zero Gravity Flammability
M512	Materials Processing Facility
M551	Metals Melting Task
M552	Exothermic Heating Task
M553	Sphere Forming Task
M554	Composite Casting Task
M555	Single Crystals Growth Task
T002	Manual Navigation Sightings
T003	In-Flight Aerosol Analysis
T025	Coronagraph Contamination Measurement
T027	ATM Contamination Measurement

Skylab offers the opportunity to develop quantitative understanding of the space environment effects on materials and functional devices. In addition, measurements are planned to better understand the way the spacecraft alters its local environment. The technology experiments support the Skylab program objectives by providing information on:

A. Degradation and characteristics of thermal control coatings exposed to space.

B. Behavior and propagation of flames in zero gravity.

C. Behavior of materials and processes in zero gravity.

D. Spacecraft contamination effects on solar instruments.

E. Navigation devices.

The materials processing in space investigations will provide insight into the feasibility of performing manufacturing operations in space to produce materials with unique or superior properties over those which can be made on Earth. In addition they are designed to evaluate the feasibility of electron beam and thermo welding in zero gravity as well as examine molten metal phenomena for selected materials.

**This experiment is integrated by the Manned Spacecraft Center.*

D008 RADIATION IN SPACECRAFT*

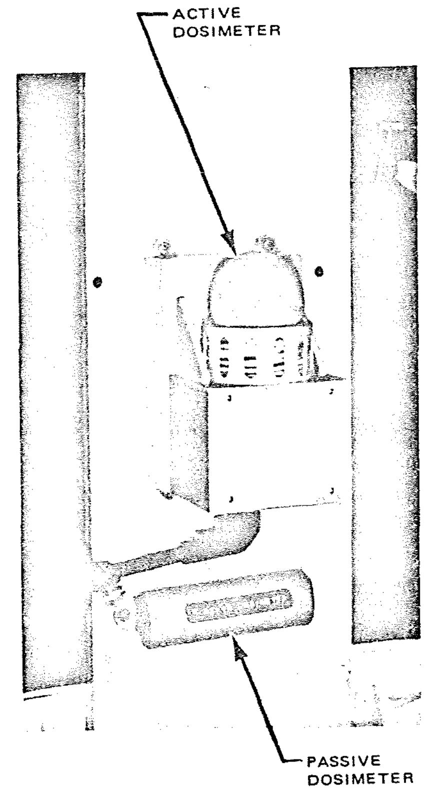
PURPOSE: Test advanced active and passive dosimetry instruments and techniques for use on future manned space flights; provide criteria for prediction of radiation hazards based on different orbital trajectories and space radiation environments.

SIGNIFICANCE: Provides data to interpret the radiation-induced biological effects on man.

EQUIPMENT USED:
- Active and Passive Dosimeters

CREW INVOLVEMENT: One crewman is a participant/subject in this experiment. Dosimeter measurements will be made at 14 locations within the Apollo Command Module including 9 positions on the crewman. This will be accomplished at least two times in the South Atlantic anomaly and will require one minute at each sensor location. The procedure will be repeated twice for the primary cosmic survey for two minutes at each sensor location. In the event of a significant solar flare the operation will be repeated.

**This experiment is integrated by the Manned Spacecraft Center.*



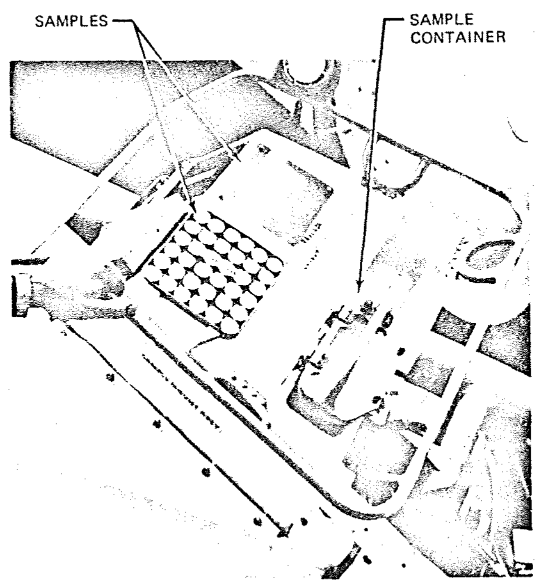
D024B THERMAL CONTROL COATINGS

PURPOSE: Expose selected thermal control coatings to space environment in order to compare results with ground-based simulations and to determine mechanisms of degradation caused by space radiation.

SIGNIFICANCE: Contribute to design of future space vehicles.

EQUIPMENT USED:
- Thermal Control Coating Sample Panels
- Return Containers
- Photographic Equipment

CREW INVOLVEMENT: One crewman retrieves one of two sample panels from outside the Airlock Module. The second panel is removed during a subsequent flight.



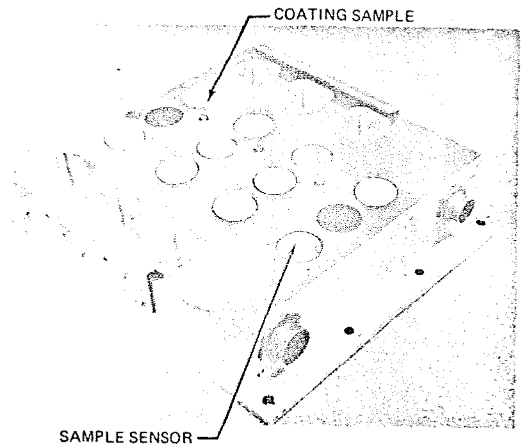
EXPERIMENT ASSEMBLY
MOUNTED ON AIRLOCK MODULE TRUSS

M415 THERMAL CONTROL COATINGS

PURPOSE: Determine degradation effects of prelaunch, launch, and space environments on absorptivity/emissivity characteristics of thermal control coatings.

SIGNIFICANCE: Experiment data will be useful in correlating space environment simulation experiments and will provide realistic parameters for spacecraft thermal control system design.

EQUIPMENT USED:
- Thermal Control Coating Sensor Panels

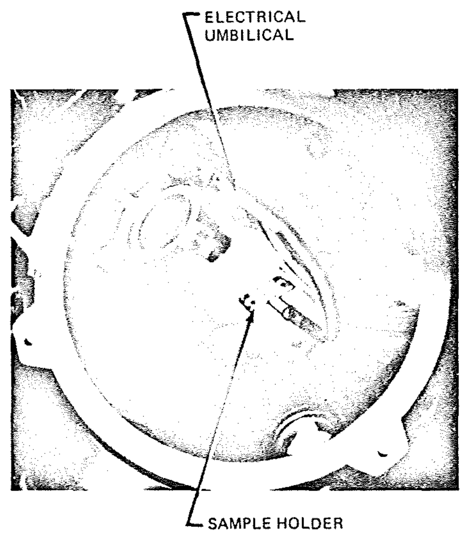


M479 ZERO GRAVITY FLAMMABILITY

PURPOSE: Ignite various materials in 5 psia cabin atmosphere within the work chamber of the Materials and Processes Facility to determine the extent of surface flame propagation-flashover to adjacent materials, etc., surface and bulk flame propagation rates under zero convection, and self-extinguishment properties and extinguishment by vacuum and water spray.

SIGNIFICANCE: Ignition, propagation, and extinguishment characteristics of various non-metallics are required for the design of safety and reliability features in future manned spacecraft.

EQUIPMENT USED:
- Materials Processing Equipment Facility
- Flammability Specimen Container
- Photographic Equipment



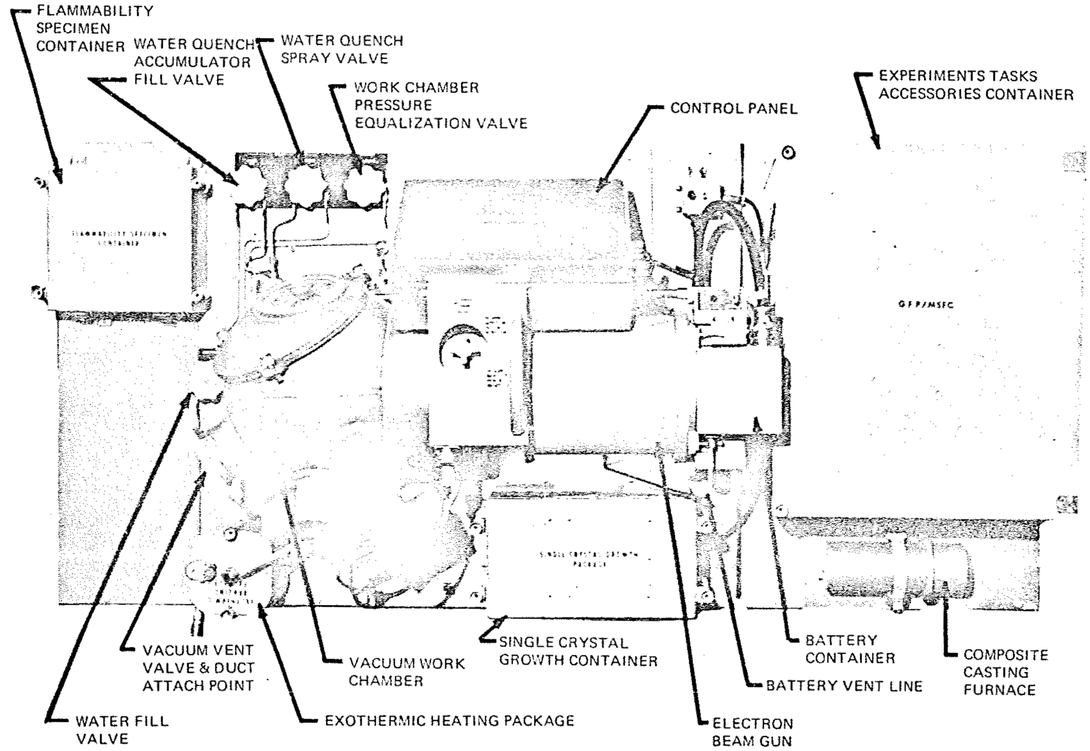
M512 MATERIALS PROCESSING IN SPACE

PURPOSE: Explore space manufacturing applications of molten phenomena such as molten metal flow, freezing patterns, thermal stirring, fusion across gaps and surface tension by performing five experimental tasks and experiment M479.

SIGNIFICANCE: Construction, assembly and repair of structures outside the Earth environment and retrieval of valuable products for use on Earth.

EQUIPMENT USED:
- Materials Processing Experiment Facility
- Experiments Task Accessories Container

CREW INVOLVEMENT: One crewman is required to perform these experiments. The basic functions performed are installation of the experiment equipment or specimen in the work chamber, observation and monitoring of the experiment, and removal of the equipment or specimen after experiment completion.

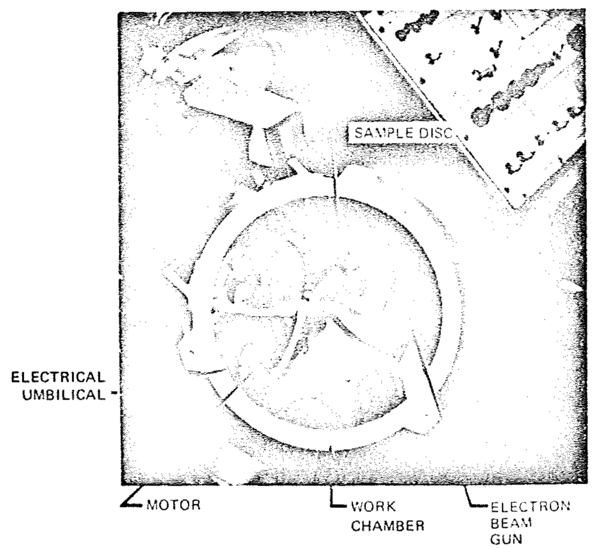


M551 METALS MELTING TASK

PURPOSE: Examine the molten metal flow characteristics of various metal alloys using the electron beam generating device as a heat source.

SIGNIFICANCE: Study and evaluate the molten metal flow characteristics under zero gravity and space vacuum conditions for comparison with 1-g simulation and development of better manufacturing processes.

EQUIPMENT USED:
- Materials Processing Experiment Facility
- Experiments Tasks Accessories Container

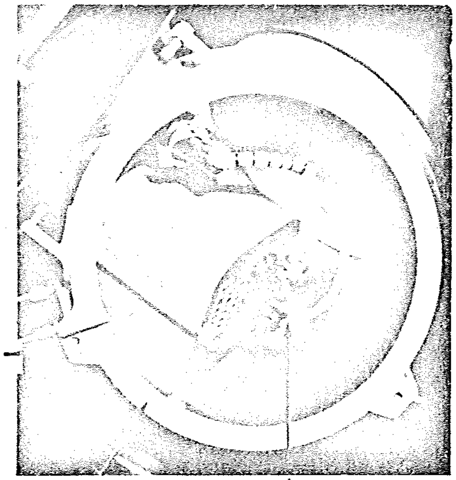


M552 EXOTHERMIC HEATING TASK

PURPOSE: Develop a stainless steel tube joining technique, study and evaluate the flow and capillary action of molten brazing material and demonstrate the feasibility of exothermic reaction in space.

SIGNIFICANCE: Evaluate assembly and repair of structures outside the Earth environment and evaluate the flow and capillary action of molten braze material in space.

EQUIPMENT USED:
- Materials Processing Experiment Facility
- Experiments Tasks Accessories Container

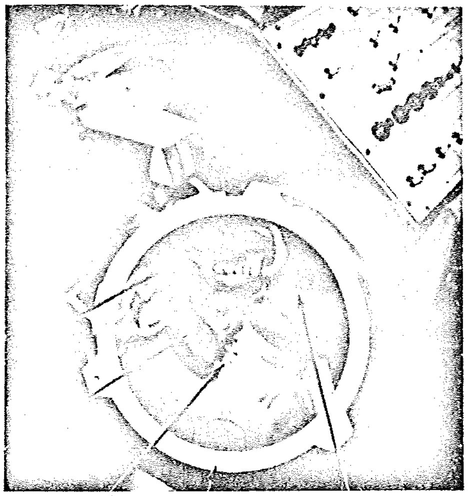


M553 SPHERE FORMING TASK

PURPOSE: Fabricate spherical shapes by taking advantage of the virtual absence of a gravitational field.

SIGNIFICANCE: Determine feasibility of manufacturing perfect spheres in zero gravity and study type of surface finish obtained. Manufacture of bearings for future applications.

EQUIPMENT USED:
- Materials Processing Experiment Facility
- Experiments Tasks Accessories Container



M554 COMPOSITE CASTING TASK

PURPOSE: Fabricate composite materials in a space vacuum by melting whisker dispersed aluminum and unidirectional solidification of two aluminum alloys.

SIGNIFICANCE: The specimens will be examined to determine the uniformity of the fiber whisker dispersion and will be compared with those cast on Earth to determine improvements of the metallurgical structure. Determine feasibility of future space manufacture of composite materials.

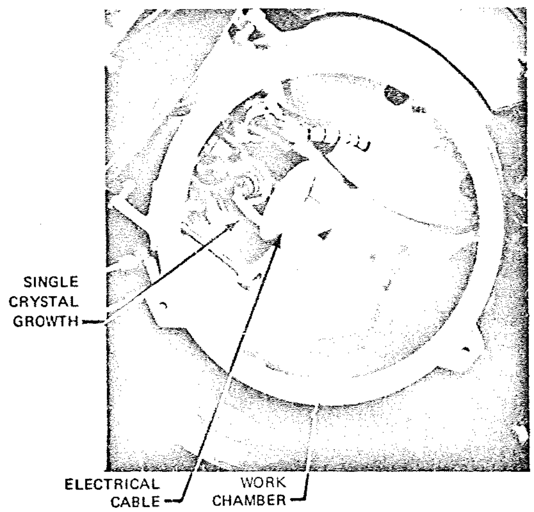
EQUIPMENT USED:
- Materials Processing Experiment Facility
- Experiments Tasks Accessories Container

M555 SINGLE CRYSTALS GROWTH TASK

PURPOSE: Grow unique single crystals of gallium arsenide in space vacuum.

SIGNIFICANCE: Determine feasibility of growing single crystals in space environment and retrieval of products for use on Earth.

EQUIPMENT USED:
- Materials Processing Experiment Facility
- Experiments Tasks Accessories Container



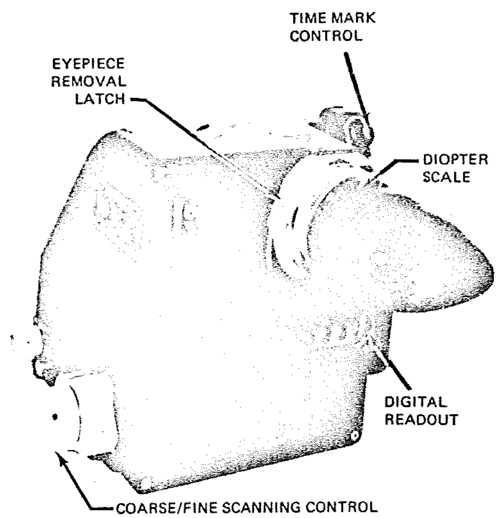
T002 MANUAL NAVIGATION SIGHTING

PURPOSE: Investigate effects of space flight environment (including long mission time) on ability to take manual space navigation measurements.

SIGNIFICANCE: Results of experiment, compared with data gathered in simulators, high flying aircraft and Gemini spacecraft, will provide error models for use in future designs of manual space navigation systems.

EQUIPMENT USED:
- Sextant
- Stadimeter

CREW INVOLVEMENT: One crewman performs navigation measurements using hand-held sextant and stadimeter; record data using the Speaker Intercom.



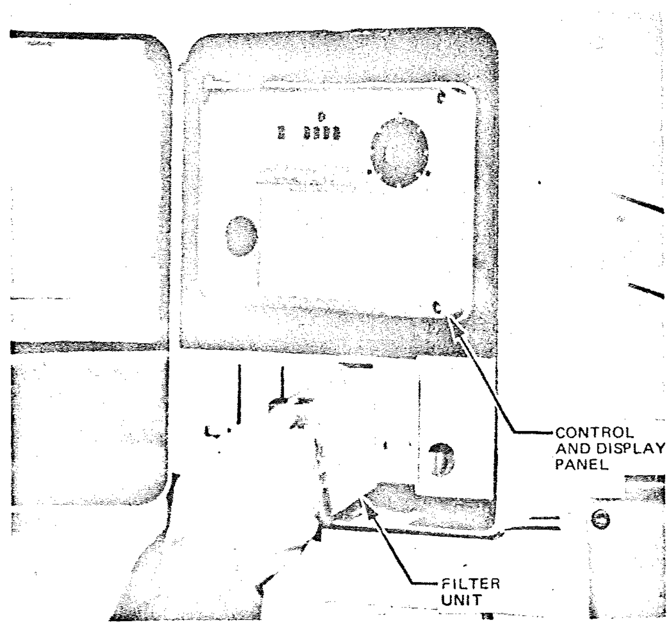
T003 IN-FLIGHT AEROSOL ANALYSIS

PURPOSE: Measure, in the size range having physiological significance, aerosol particle composition, concentration and size distribution inside spacecraft to assess potential health hazards, source of particles and adequacy of air distribution, circulation and filtration.

SIGNIFICANCE: Information could lead to changes in spacecraft materials, air circulation provisions and housekeeping procedures.

EQUIPMENT USED:
- Aerosol Analyzer and Storage Container
- Skylab Universal Mount

CREW INVOLVEMENT: One crewman to transport aerosol analyzer throughout Skylab; utilize Skylab universal mount, operate analyzer, observe readout, and record data. After taking approximately 100 measurements, the data card and filter particle collection device are stowed in Command Module for Earth return.



T025 CORONAGRAPH CONTAMINATION MEASUREMENT

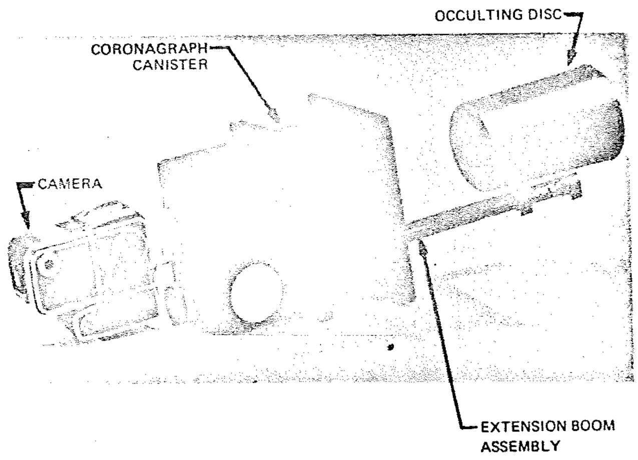
PURPOSE: Determine the presence of any changes in particle atmosphere, if one exists, due to transfer firings, waste dumps, vehicle orientation, and time decay of such atmospheric concentrations; nature and extent of the Sun's F-Corona.

SIGNIFICANCE: Results of this experiment will permit an evaluation of the influence of light scattering on Apollo Telescope Mount experiment data.

EQUIPMENT USED:

- Coronagraph Canister including Occulting Discs and Extension Boom Assembly
- Photographic Equipment

CREW INVOLVEMENT: One crewman sets up the experimental apparatus in the Scientific Airlock and completes a 27 photographic exposure sequence during 5 nonconsecutive orbits.



T027 APOLLO TELESCOPE MOUNT CONTAMINATION MEASUREMENT

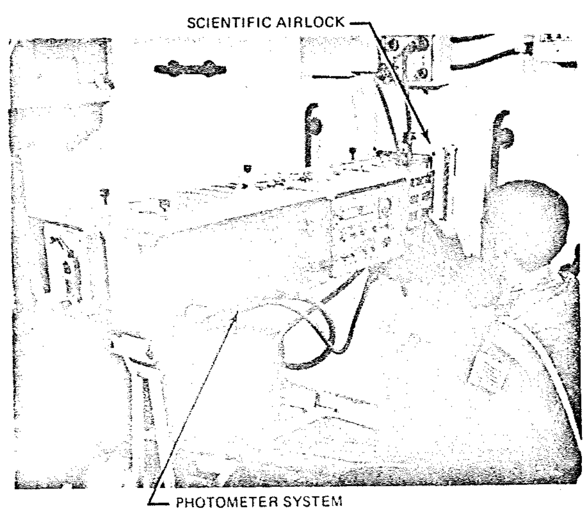
PURPOSE: Determine change in optical properties of various surfaces caused by contaminants near the spacecraft on a real-time basis plus postflight analysis. Measure sky brightness background caused by solar illumination of contaminants.

SIGNIFICANCE: Data used to study general problem of near spacecraft atmospheric contamination and effect on astronomy and Earth photography experiments. Will aid data analysis for Apollo Telescope Mount experiments.

EQUIPMENT USED:

- T027/S073 Photometer System
- Optical Surface Array System

CREW INVOLVEMENT: One crewman is involved in set up of experiment using Scientific Airlock and deployment of sample array for 120-hour period. Calibration procedures are required for day and night data collection periods.



4.2.6 Operations Experiments

Experiment No.	Title
M487	Habitability and Crew Quarters
M509	Astronaut Maneuvering Equipment
M516	Crew Activities/Maintenance*
T013	Crew/Vehicle Disturbance
T020	Foot Controlled Maneuvering Unit

The operations experiments were chosen to gain engineering data on man's capabilities in the weightless environment, or evaluate hardware designed to increase the crew's ability to move and work in such an environment. These investigations support the broad Skylab program objectives of developing and advancing man's capability to live and perform useful work in space. Evaluations will be made of the crew's ability to perform zero-gravity tasks requiring delicate manipulations. A series of measurements will be taken to determine the effects of mission duration and prolonged weightlessness on the crew's ability to repeat these same tasks in a skillful and timely manner. Accurate measurements will be made of vehicle disturbances caused by crew activities. These results are essential to define allowable crew motions during the conduct of experiments requiring low levels of acceleration (10^{-4} to 10^{-5} g), or pointing with extreme accuracy and for designing attitude control systems for future space missions. The data obtained will be applied to future programs for extravehicular activities such as assembling large space structures, inspection and maintenance, refurbishment, rescue, and data retrieval. Several astronaut maneuvering units and labor saving aids will be evaluated during the mission.

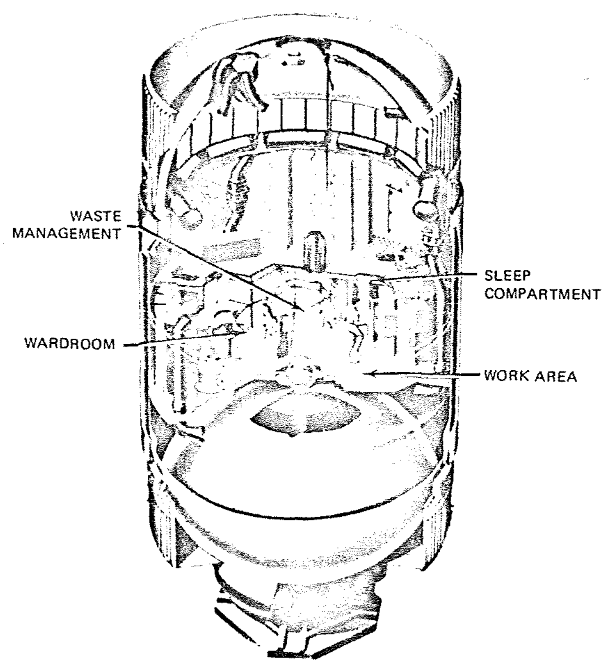
**No equipment used – description not included*

M487 HABITABILITY AND CREW QUARTERS

PURPOSE: Evaluate the habitability features of the Orbital Workshop in engineering terms for use in designing future manned spacecraft.

SIGNIFICANCE: Data will form the basis for verifying existing spacecraft habitability criteria and for establishing requirements for more advanced spacecraft.

EQUIPMENT USED:
- Environmental Sensors Package (air velocity, temperature, humidity, acoustics)
- Photographic Equipment



M509 ASTRONAUT MANEUVERING EQUIPMENT

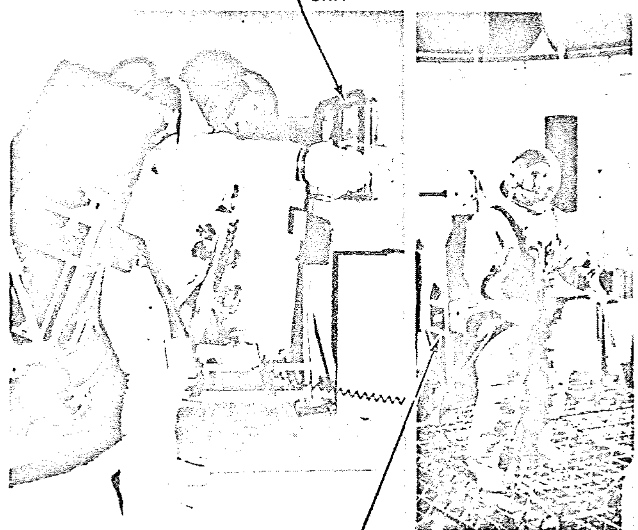
PURPOSE: Evaluate utility of several astronaut maneuvering techniques.

SIGNIFICANCE: Evaluate ground based simulation techniques through in-flight comparisons. Identification of fundamental characteristics of manned maneuvering will establish design requirements for future maneuvering units.

EQUIPMENT USED:

- Automatically Stabilized Maneuvering Unit
- Hand-Held Maneuvering Unit
- Photographic Equipment
- Propellant Supply Subsystem

CREW INVOLVEMENT: One crewman participates directly in the experiment, but two crewmen are required to execute particular operations at any given time when one crewman is the participant and the other provides safety support, and observation functions. At various phases in the experiment the participating crewman will perform shirtsleeve and spacesuit evaluation of the maneuvering equipment.



T013 CREW/VEHICLE DISTURBANCE

PURPOSE: Measure the effects of various crew motions on the dynamics of manned spacecraft; specifically, the torques, forces, and vehicle motions produced by the astronaut's body motions.

SIGNIFICANCE: Crew motion simulations have indicated that vehicle motions and disturbances could result from even the simplest crew movements. These motions may affect high accuracy experiments such as the Apollo Telescope Mount.

EQUIPMENT USED:

- Force Measuring System
- Limb Motion Sensor Assembly

CREW INVOLVEMENT: One crewman with the Limb Motion Sensor Assembly garment donned performs body movements and stationary movements while attached to the Force Measuring System. His activities are photographed while the measuring system and Limb Motion Sensor Assembly data are recorded.

T020 FOOT CONTROLLED MANEUVERING UNIT

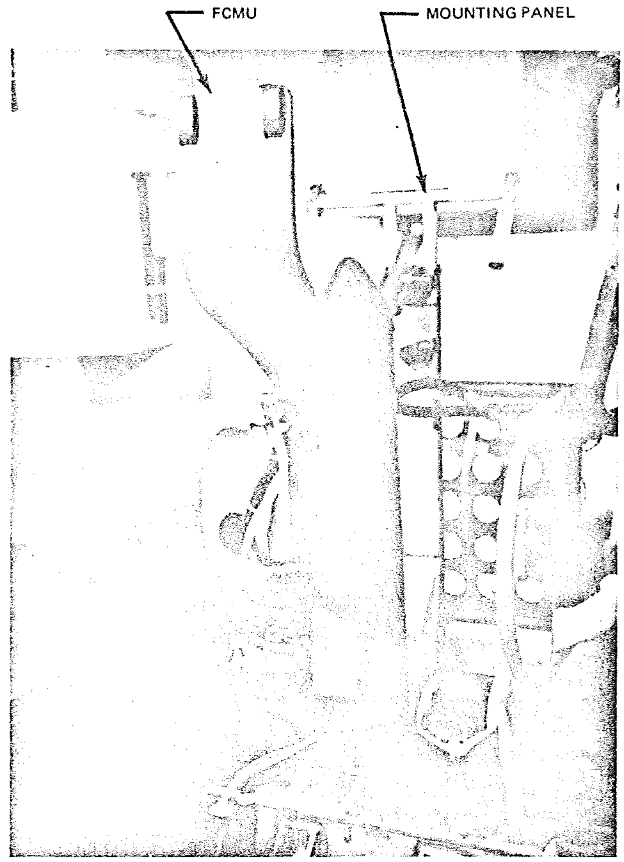
PURPOSE: Provide information pertaining to the design and use of astronaut maneuvering systems by conducting in-flight and ground based evaluations of an unstabilized experimental device.

SIGNIFICANCE: Obtain information in the design of subsequent operational systems based on this concept. Determine feasibility of the concept of extravehicular activities space locomotion for future space missions. Evaluate ground based simulation techniques through in-flight comparisons.

EQUIPMENT USED:

- Foot Controlled Maneuvering Unit (FCMU)
- Propellant Supply Subsystem
- Photographic Equipment

CREW INVOLVEMENT: One crewman performs prescribed maneuvers while another acts as an observer, cameraman, and safety man. Approximately 10 hours is required for a complete experiment cycle.



4.3 SKYLAB STUDENT PROJECT EXPERIMENTS

The selection of 25 national finalists in the Skylab Student Project was made by the National Science Teachers Association and NASA. A number of these experiments and demonstrations proposed by high school students will be performed in space aboard the Skylab in 1973. Proposals by the 25 finalists (Table 4-1) were chosen from 3,409 entries submitted by secondary school students across the nation and overseas. The Project is designed to stimulate student and teacher interest in space science and technology by directly involving secondary school students in space based research.

4.4 EQUIPMENT AND SENSORS CHARACTERISTICS

The experimental equipment, instruments and apparatus onboard Skylab represent a broad capability in terms of the range and extent of measurements and observations which can be made. The characteristics of these devices are found in Tables 4-2 through 4-5. For comparative purposes, four groupings have been prepared which include optical instruments, environmental sensors, medical instruments, and a general listing of other experimental apparatus. An expanded description of the capabilities and characteristics of the M512 Materials and Processes Facility is found in Table 4-6.

Table 4-1. National Science Teachers Association (NSTA) Skylab Student Poject Finalists

Skylab No.	Skylab Title	NSTA No.	NSTA Title	Student Name
			HS-10 Series – EARTH OBSERVATIONS	
HS-11	Heat Absorption	IX-P-13	Earth's Absorption of Radiant Heat	Joe B. Zmolek
HS-12	Volcanic Study	XI-R-17	Space Observation and Prediction of Volcanic Eruptions	Troy A. Crites
			HS-20 Series – ASTRONOMY	
HS-21	Libration Cloud's	IV-R-19	Photographic of Libration Clouds	Alison Hopfield
HS-22	Objects in Mercury's Orbit	XI-R-01	Possible Confirmation of Objects Within Mercury's Orbit	Daniel C. Bochsler
HS-23	Quasars	XII-V-06	Spectrography of Selected Quasars	John C. Hamilton
HS-24	X-Ray Stellar Classes	X-V-02	X-Ray Content in Association with Stellar Spectral Classes	Joe W. Reihs
HS-25	X-Rays from Jupiter	XII-V-07	X-Ray Emmision From the Planet Jupiter	Jeanne L. Leventhal
HS-26	UV from Pulsars	VI-V-20	A Search for Pulsars in Ultraviolet Wavelengths	Neal W. Shannon
			HS-30 Series – BACTERIOLOGY	
HS-31	Bacteria and Spores	II-V-08	Behavior of Bacteria and Bacteria Spores in the Skylab and Space Environment	Robert L. Staehle
HS-32	In-Vitro Immunology	III-P-01	An In-Vitro Study of Selected Isolated Immune Pheomena	Todd A. Meister
HS-33	Micro-Organisms in Zero and Aritificial Gravity	II-X-09	Effects of Intermittent Long Duration Exposure to Zero and Artificial Gravity	Keith L. Stein
			HS-40 Series – PHYSIOLOGY	
HS-41	Motor Sensory Performance	X-V-24	A Quantitative Measure of Motor Sensory Performance During Prolonged In-flight Zero Gravity	Kathy L. Jackson
			HS-50 Series – ZOOLOGY	
HS-51	Chick Embryology	IX-R-21	Chicken Embryology in Zero Gravity	Kent M. Brandt
HS-52	Web Formation	I-V-23	Web Formation In Zero Gravity	Judith S. Miles
			HS-60 Series – BOTANY	
HS-61	Plant Growth	XI-R-27	Plant Growth in Zero Gravity	Joel G. Wordekemper
HS-62	Plant Phototropism	XII-V-23	Phototropic Orientation of an Embryo Plant in Zero Gravity	Donald W. Schlack
HS-63	Cytoplasmic Streaming	XI-S-30	Cytoplasmic Streaming in Zero Gravity	Cheryl A. Peltz
			HS-70 Series – PHYSICS	
HS-71	Colloidal State	X-P-21	Effect of Zero Graivty on the Colloidal State of Matter	Keith D. McGee
HS-72	Capillary Study	IX-P-06	Capillary Studies in a State of Free Fall	Roger G. Johnston
HS-73	Powder Flow	IX-P-09	Testing Flow Properties of Powdered Solids in Zero Gravity	Kirk M. Sherhart
HS-74	Mass Measurement	VIII-P-15	Zero Gravity Mass Measurement	Vincent W. Converse
HS-75	Brownian Motion	I-P-04	Brownian Motion and Dissolution of a Salt in Zero Gravity	Gregory A. Merkel
HS-76	Neutron Analysis	X-P-20	Earth Orbital Neutron Analysis	Terry G. Quist
HS-77	Universal Gravity	II-P-16	Universal Gravitational Constant: Determination in Space	James E. Healy
HS-78	Wave Motion	VII-S-11	Wave Motion Through a Liquid in Zero Gravity	W. Brian Dunlap

Table 4-2. Optical Instruments

Instrument	Spectral Range (Wavelength)	Spectral Resolution (ΔWavelength)	Field of View	Spatial Resolution	Film Data Produced	Electronic Data Produced	Remarks
EARTH VIEWING SENSORS							
Earth Terrain Camera	0.37 to 0.83 μM	Film Dependent	16 deg	13M From 235 nmi	5 by 5 in. Images	—	
Infrared Spectrometer	0.4 to 2.4 μM, 6.2 to 15.5 μM	0.01 to 0.3 μM	1/4 deg	1/4 mi	16 mm Images	10 bit 684 SPS	Slew +45 to −10 deg along track, ±20 deg across track
L-Band Radiometer	21 cm	NA	15 deg	60 NM	—	10 bit 18 SPS	
Multispectral Photographic Camera	0.4 to 0.9 μM	Film Dependent	24 deg	100 ft	70 mm Images	—	Six boresighted 6 in. FL Cameras
Microwave Radiometer/ Scatterometer/Altimeter	2.2 cm	NA	1.5 deg	6 NM	—	10 kbs PCM	Scan 0 to 48 deg along track, 0 to ±48 deg across track.
Multispectral Scanner	0.4 to 12.5 μM 13 bands	0.05 to 2.3 μM	0.01 deg	260 ft	—	22 8-bit PCM channels	10 deg conical scan
SOLAR OBSERVATION INSTRUMENTS							
UV Scanning Polychromator Spectroheliograph	300 to 1,350 Å	0.2 Å	5 by 5 min	5 sec	—	ATM Tape	5 by 5 min raster scan
UV Spectrograph	970 to 1,970 Å, 1,940 to 3,940 Å, 170 to 550 Å	0.08 Å	Solar disc	—	35 by 258 mm strip	TV monitor	
White Light Coronagraph	5,400 to 6,400 Å	NA	6 Solar radii	—	35 mm Images	—	
X-Ray Telescope	2 to 8 Å, 8 to 20Å	NA	—	—	70 mm	—	
X-Ray Spectrographic Telescope	2 to 20 Å, 44 to 60 Å	NA	Solar disc	2 sec	70 mm	—	
XUV Coronal Spectroheliograph	150 to 350 Å, 300 to 650 Å	0.13 Å	Solar disc	5 sec	35 by 248 mm strip	—	
OTHER INSTRUMENTS							
Chronagraph Canister and Accessories	3,700 to 8,300 Å	NA	52 deg	3μ at 3 ft	70 mm Images	—	3 deg 40 min occulting disc
Microscope–Camera Subsystem	3,500 to 8,500 Å	NA	20X, 40X	—	16 mm Images	—	
Optical and Film Canister	1,400 to 3,500 Å	NA	4 by 5 deg	15 sec	70 mm	—	60 deg conical scan
Photometer System	4,000 to 8,200 Å	20 to 250 Å	6 deg, 3 deg, 1 deg	—	16 mm	Mag Tape	
Spectrographic Assembly	10 to 100 Å, 20 to 200 Å	0.05 to 0.08 Å	1/2 deg	—	70 mm	—	
Telescope/Spectrograph/ Camera Assembly	1,800 and 3,100 Å	600 Å	7 by 9 deg	—	16 mm 2 by 3 in. plates	—	60 deg conical scan

Table 4-2. Optical Instruments (Continued)

Instrument	Spectral Range (Wavelength)	Spectral Resolution (ΔWavelength)	Field of View	Spatial Resolution	Film Data Produced	Electronic Data Produced	Remarks
UV Airglow Horizon Cameras	2,550 to 2,700 Å, 3,200 to 6,300 Å	NA	43 deg	—	35 mm	—	

Table 4-3. Environmental Sensors

Item	Parameter Measured	Range and Accuracy	Form of Data	Used With
Aerosol Analyzer	Airborne particulate matter — categorizes and counts particles.	Channel 1:1 to 3μ counter 0000 to 9999 + overflow light. Channel 2:3 to 9μ up to 500,000. Channel 3:9 to 100μ particles per ft^3.	Visual digital readout for manual recording.	T003
Detector Cassette and Motor Drive Support Unit	Impact phenomena and debris.	Impact crater sizes — 0.05 and larger impact particle composition.	Ground return of exposed panels (4 sets of 2 panels each opened 90 deg to each other).	S149
Dosimeters, Active	Radiation dose rate, proton — alpha particle spectra.	Dose rate — 0.001 to 50 rad/hr 0 to 28 counts/min anticoincidence 0 to 4,000 counts/min.	Recorded on tape and TM to ground-CM-DSE.	D008
Dosimeters, Passive	Total mission dose, particle type.	0.010 to 10,000 rads incident on meter.	Passive — follows input dosage — readout on ground after return.	
Environmental Sensor Package	Relative humidity, air movement, sound level, temperature.			
Nuclear Emulsion Detector Package	Charge spectrum and composition of heavy primary nuclei	$Z \geqslant 10$ — Passive	Analysis performed on ground after return of exposed emulsion.	S009
Optical Surface Array System	Quartz microbalance — surface film buildup. Photometer — brightness and polarization.	TBS Wavelength 0.4 to 0.82μ. Polarization — 0 to 180 deg. Intensity — calibration 10 to 10^{-4} ft lamberts.	Auto. programs available 10 filter sequence — 2 min 10 samples/sec tape recorder — TM to ground. Sample rate 320 SPS	T027
Thermal Control Coating Sensor Panels	Absorptivity/Emissivity characteristics by recording temperature of control coatings.		TM via IU systems	M415
Thermal Control Coating Sample Panels and Return Container	Material Degradation	N/A — Passive	Samples returned to Earth for analysis.	D024

Table 4-4. Biomedical Instruments and Devices

Legend:

KG	Kilogram
μV	Microvolt
PSIA	Pounds per square inch absolute
ℓ	Liters
°	Degrees
SEC	Seconds
RPM	Revolutions per minute
mmHg	Millimeters of mercury
F	Farenheit
mV	Millivolt
BPM	Beats per minute
%	Percent
M	Minutes
W	Watts

Biomedical Measurement	Range	Units	Blood Pressure Measurement System	Body Mass Measurement Device	Body Temperature Measurement System	Electroencephalograph/Electro-oculograph	Ergometer System	Experiments Support System	Leg Volume Measurement System (Plethysmograph)	Lower Body Negative Pressure Device	Metabolic Analyzer	Otolith Test Goggles	Rotating Litter Chair	Specimen Mass Measurement Device	Vectorcardiogram System
Body Mass	0 → 100	KG		●											
Brain Activity Waveform	0 → 300	μV				●									
Cabin Pressure	0 → 6	PSIA						●							
Carbon Dioxide Production	0 → 4	ℓ/M									●				
Chair Angular Acceleration	0 → 6	$^\circ SEC^{-2}$											●		
Chair Rotational Speed	0 → 31	RPM											●		
Chair Tilt	±20	°											●		
Chamber Differential Pressure	0 → –50	mmHg								●					
Chamber Temperature	60 → 110	°F								●					
Ear Canal Temperature	95 → 105	°F			●										
Electrocardiographic Potential	0 → 3	mV													●
Eye Movement Waveform	0 → 500	μV				●									
Heart Rate	40 → 200	BPM													●
Leg Volume Change	–1 → 5	%							●						
Oxygen Consumption	0 → 4	ℓ/M									●				
Pedal Speed	40 → 90	RPM					●								
Respiratory Minute Volume	0 → 7	ℓ									●				
Respiratory Rate	0 → 150	ℓ/M									●				
Specimen Mass	0.05 → 1	KG												●	
Subject Position	±45	°										●			
Systolic and Diastolic Pressure	40 → 250	mmHg	●												
Time Remaining	0 → 100	M						●							
Work Load	25 → 300	W					●								

Table 4-5. Other Experimental Apparatus

Item	Function/Description	Form of Data	Used With
Automatically Stabilized Maneuvering Unit (ASMU)	This unit gives the astronaut capability to translate in 6 degrees of freedom and provides him with a stable platform on which to conduct manual tasks, such as, inspection, removal/replacement, repair, etc. Backmounted with multiple fixed position thrustors fed by 100 percent nitrogen from environmental control system. Automatic attitude control provided by direct, rate gyro, or control moment gyro. The ASMU contains attitude control, cold gas propulsion, power instrumentation, and controller/display and the following subsystems: (1) Propellant Supply Subsystem – (PSS) – A high pressure gas bottle (located in the ASMU) will be used for supplying propulsion gas (O_2) when umbilicals are not used. The discharge pressure is regulated to 150 psia. This bottle will be recharged from the Airlock Module recharge station as needed. (2) Transmitter Subsystem – Consists of data recorder unit and an antenna. This subsystem obtains its operating electrical power from the battery pack in the ASMU.	16mm film and crew comments. 47 TM measurements on tape.	M509
Biopack Subsystem	Container and biopack, each with 12 biopack cells.	Uses S015 microscope camera subsystem.	S015
Earth Resources Experiment Package Support Equipment	Provide for EREP central control data management and electrical power distribution. Provide limited sensor calibration capability and a telescope for tracking EREP ground sites.	Tape recorder – two speed, 20,000 bits/inch, 1.6 billion bits/tape.	S190, S191, S192, S193, S194
Foot Controlled Maneuvering Unit	This unit provides astronaut capability (in either shirtsleeve or spacesuit mode) to change attitude through large angles about each axis, translate either head first or feet first and decelerate to zero velocity, stabilize attitude and position and maintain fixed position relative to a stationary object, translate around objects, and recover from tumbling motions. The ASMU will be worn as a backpack during experiments with this unit. The FCMU consists of the basic propulsion system (using 100 percent nitrogen) and the foot-operated control unit which is mounted between the legs of the astronaut. It consists of a framework with a saddle type seat and restraining straps to hold the astronaut in a fixed position. Two 4-nozzle thrustor assemblies (pitch and translation) are attached to the framework just outboard of the feet. The thrusts developed at the pitch thrustor assembly and the translational thrustor assembly are 1 and 2 lbs, respectively. The feet are attached to individual pedal-type controllers by a foot restraint system compatible with the constant wear garment and pressure suit boots.	16mm film and crew comments. 22 TM measurements on tape.	T020
Force Measuring System	Measure 12 forces over range of –50 to +50 lbs.	20 samples/sec stored in AM recorder and telemetered to ground for post-experiment analysis.	T013
Limb Motion Sensor	Measure 16 limb angles; 12 over 0 to 320 deg range, 4 over 0 to 174 deg range.		
Hand-Held Maneuvering Unit (HHMU)	This unit, which is used in conjunction with the ASMU, provides the astronaut capability to perform pure rotations, short translations, retrothrust, stablization and orientation, and maneuvering around objects. It can be used in the shirtsleeve mode with or without umbilicals and in the pressure-suited mode with umbilicals. This unit is a handheld and handoperated propulsion device with one pusher and two tractor thrustors. It plugs into the ASMU with a short umbilical for propellant and instrumentation. Spacecraft gas (oxygen) power and communications are provided by a propulsion gas umbilical (PGU), a special minimum weight, maximum flexibility umbilical.	16mm film and crew comments. 47 TM measurements on tape.	M509

Table 4-6. M512 Materials and Processes Facility

Item	General Description	Services Available	Used With
Materials Processing Facility	Provides a 16-1/4 inch diameter test chamber designed to accept various experiment test packages for metals melting, sphere forming, exothermic heating, composite casting, single crystal growing, and materials combustion.	Electron beam gun (20 KV), 28 vdc power, water spray, vacuum line (4 inch dia), photo port and lighting (16mm movie), viewing port (X-ray glass), pressure gages (15 psia to 10^{-5} TORR), AM tape recorder for voice comments on experiments.	M479, M512

4.5 EXPERIMENT REQUIREMENTS AND SKYLAB ASSIGNMENTS

The matching of the Skylab facility resources to particular experiment support requirements is delineated in this section. The general support requirements for each experiment, in terms of weight, volume, average power, crew time, data, viewing, and environment are presented in Table 4-7. The Skylab program mission plan required consideration of the following factors (1) individual experiment priority, (2) experiment duration, (3) crew requirements, (4) orbital pointing requirements, and (5) Skylab support capability.

The medical experiments are scheduled to begin early in the mission. This results from the requirement to establish man's adaptability to a zero gravity environment and his ability to live and work efficiently in zero gravity conditions. The flight assignment of each experiment is presented in Table 4-8. Other information in Table 4-8 complements the experiment support requirements in Table 4-7.

Table 4-7. Experiment Requirements

Experiment Number	Experiment Title	Weight (lb)	Volume (ft^3)	Avg Power (W)	Planned Crew Time for SL-1/2 (hr:min)	Form of Data Generated						Viewing Rqmts			Environ. Rqmts		
						Samples	Film	Mag Tape	Voice	TM	Log Book	Earth	Solar	Inertial	Vacuum	Shirtsleeve	EVA
M071	Mineral Balance	*	*	*	117:04	•										•	
M073	Bioassay of Body Fluids	*	*	*	Included in M071	•										•	
M074	Specimen Mass Measurement	*	*	10	3:00				•		•					•	
M092	In-Flight Lower Body Neg. Press.	175	4.0	52	104:24				•	•						•	
M093	Vectorcardiogram	52	1.1	15	Included in M092				•	•						•	
M112–M115	Blood Studies	36	1.5	30	2:25	•										•	
M131	Human Vestibular Function	248	30.0	197	32:15					•	•					•	
M133	Sleep Monitoring	38	1.2	10	3:15					•	•					•	
M151	Time and Motion Study	126	1.8	166	Included in Other Experiments		•									•	•
M171	Metabolic Activity	448	65.0	40	Included in M092				•	•	•					•	
M172	Body Mass Measurement	82	19.0	4	1:30				•		•					•	
T003	In-Flight Aerosol Analysis	23	0.5	None	11:56	•					•						
D024B	Thermal Control Coatings	10	0.2	16	Included in ATM Time	•									•		
M415	Thermal Control Coatings	40	6	3	None					•					•		
M479	Zero Gravity Flammability	15	0.8	40	Performed on SL-1/-3		•				•				•	•	
M512	Materials Process. in Space**	357	3.7	342	7:06	•	•				•				•	•	
T002	Manual Navigation Sightings	31	0.6	None	Performed on SL-1/-3 and SL-1/-4				•		•			•		•	
T025	Coronagraph Contamination Measurement	62	2.0	None	4:39		•				•			•	•		
T027	ATM Contamination Measurement	344	14.0	128	38:07	•	•	•		•				•	•		
M487	Habitability and Crew Quarters	*	*	166	Included in Other Experiments											•	
T013	Crew/Vehicle Disturbance	78	5.5	203	Performed on SL-1/-4		•			•				•		•	
T020	Foot Controlled Maneuvering Unit	101	8.8	313	Performed on SL-1/-3		•			•	•					•	
S009	Nuclear Emulsion	75	1.3	20	0:30		•								•		
S019	UV Stellar Astronomy	175	0.7	None	9:15		•				•			•	•		
M509	Astronaut Maneuvering Equip.	412	47.0	242	17:36		•			•	•				•		
S020	UV/X-Ray Solar Photography	75	3.0	None	TBD		•				•		•		•		
S063	UV Airglow Horizon Photo.	105	3.0	None	4:25		•				•	•			•		
S073	Gegenschein/Zodiacal Light	See T027			Included in T027					•	•			•	•		
S149	Particle Collection	See T027			TBD	•				•	•				•		
S150	Galactic X-Ray Mapping	340	11.0	96	None					•				•	•		
S183	Ultraviolet Panorama	148	15.0	20	8:01		•	•						•	•		
S052	White Light Coronagraph	320	32.0	21	Total ATM 190:30		•			•			•		•		
S054	X-Ray Spectrographic Telescope	312	40.0	TBS	Total ATM 190:30		•			•			•		•		
S055A	UV Scanning Polychromator/ Spectroheliometer	205	23.0	61	Total ATM 190:30					•			•		•		
S056	X-Ray Telescope	354	28.0	TBS	Total ATM 190:30		•			•			•		•		
S082A	XUV Coronal Spectroheliograph	254	40.0	TBS	Total ATM 190:30		•			•			•		•		
S082B	UV Spectrometer	421	45.0	TBS	Total ATM 190:30		•			•			•		•		
S190A	Multispectral Photo. Facility	182	5.6	78	48:22		•		•		•	•				•	
S190B	Earth Terrain Camera	239	2.0	140	10:04		•				•	•				•	
S191	Infrared Spectrometer	300	11.2	200	48:22		•	•		•		•			•	•	
S192	Multispectral Scanner	300	19.4	96	48:22			•		•		•			•	•	
S193	Microwave Radiometer/ Scatterometer Radar and Altimeter	250	96.0	153	48:22			•		•		•			•	•	
S194	L-Band Radiometer	75	10.5	104	48:22			•		•		•			•	•	
D008	Radiation in Spacecraft	7	0.1	1	3:02		•				•					•	
S015	Effect of Zero Gravity on Single Human Cells	22	0.8	46	2:24		•				•					•	
S071/	Circadian Rhythm of Pocket Mice	235	11.0	109	TBD						•						
72	Circadian Rhythm of Vinegar Gnats	included in above															

**Included as part of Orbital Workshop.*

***Experiments M551 through M555 are included.*

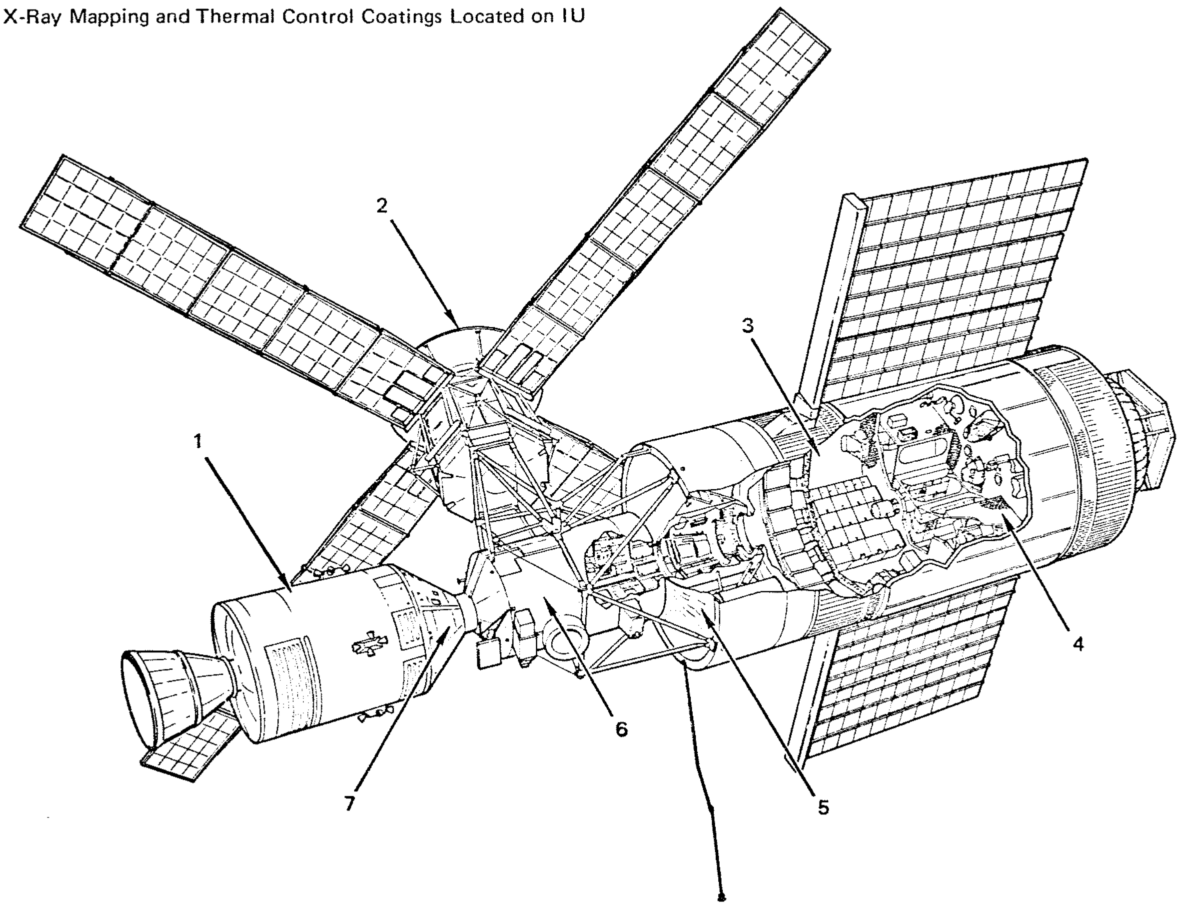
Table 4-8. Experiment Assignments

Experiment Number	Experiment Title	SL-1/2	SL-1/3	SL-1/4	Cluster Location	Crew Assigned: Commander	Crew Assigned: Pilot	Crew Assigned: Science Pilot	Data Returned: Physical (lb)	Data Returned: TM (Meas)	Data Returned: Voice Comm	Special Environ. Reqd: Shirt-sleeve	Special Environ. Reqd: Airlock	Special Environ. Reqd: EVA	Specific Orient. Reqd: Solar Inertial	Specific Orient. Reqd: Local Vertical
M071	Mineral Balance	•	•	•	OWS	•	•	•	260			•				
M073	Bioassay of Body Fluids	•	•	•	OWS	•	•	•				•				
M074	Specimen Mass Measurement	•	•	•	OWS			•			•	•				
M092	In-Flight Lower Body Neg Press.	•	•	•	OWS	•	•	•		5	•	•				
M093	Vectorcardiogram	•	•	•	OWS	•	•	•		3	•	•				
M112–M115	Blood Studies	•	•	•	OWS	•	•	•	8			•				
M131	Human Vestibular Function	•	•		OWS	•	•	•	2	36		•				
M133	Sleep Monitoring	•	•		OWS			•	6	1		•				
M151	Time and Motion Study	•	•	•	OWS	•	•	•	60			•		•		
M171	Metabolic Activity	•	•	•	OWS	•	•	•		8	•	•				
M172	Body Mass Measurement	•	•	•	OWS			•			•	•				
T003	In-Flight Aerosol Analysis	•	•	•	OWS		•		1			•				
D024B	Thermal Control Coatings	•		•	AM	•	•		2					•		
M415	Thermal Control Coatings	•			IU		None			1						
M479	Zero Gravity Flammability		•		MDA		•		10			•				
M512	Materials Process. in Space*	•			MDA		•		22			•				
T002	Manual Navigation Sightings		•	•	OWS	•					•	•				
T025	Coronagraph Contamination Measurement	•			OWS	•			4				•		•	
T027	ATM Contamination Measurement	•	•	•	OWS		•		36	25			•		•	
M487	Habitability and Crew Quarters	•	•	•	OWS	•	•	•				•				
M509	Astronaut Maneuvering Equip.	•			OWS	•			19	47						
T013	Crew/Vehicle Disturbance			•	OWS		•		3	38		•				
T020	Foot Controlled Maneuvering Unit		•		OWS	•			6	22		•				
S009	Nuclear Emulsion	•			MDA		•		30							
S019	UV Stellar Astronomy	•	•		OWS		•		15					•		
S020	UV/X-Ray Solar Photography		•	•	OWS		•		18			•	•		•	
S063	UV Airglow Horizon Photo.	•	•	•	OWS		•		11			•	•			•
S073	Gegenschein/Zodiacal Light	•	•	•	OWS		•		2	19		•	•			
S149	Particle Collection	•	•	•	OWS		•		45	4		•	•			
S150	Galactic X-Ray Mapping			•	IU		None			TBD						
S183	Ultraviolet Panorama		•	•	OWS		•		10			•	•			
S052	White Light Coronagraph	•	•	•	ATM	•	•	•	63	13				•	•	
S054	X-Ray Spectrographic Telescope	•	•	•	ATM	•	•	•	24	68				•	•	
S055A	UV Scanning Polychromator/Spectroheliometer	•	•	•	ATM	•	•	•		52				•	•	
S056	X-Ray Telescope	•	•	•	ATM	•	•	•	57	9				•	•	
S082A	XUV Coronal Spectroheliograph	•	•	•	ATM	•	•	•	183	130				•	•	
S082B	UV Spectrometer	•	•	•	ATM	•	•	•	186					•	•	
S190A	Multispectral Photo. Facility	•	•	•	MDA	•	•		112			•				•
S190B	Earth Terrain Camera	•	•	•	OWS			•	24			•	•			•
S191	Infrared Spectrometer	•	•	•	MDA	•	•		132	15		•				•
S192	Multispectral Scanner	•	•	•	MDA	•	•		–	59		•				•
S193	Microwave Radiometer/Scatterometer Radar and Altimeter	•	•	•	MDA	•	•		–	35		•				•
S194	L-Band Radiometer	•	•	•	MDA	•	•		–	19		•				•
D008	Radiation in Spacecraft	•			CM	•			7			•				
S015	Effect of Zero Gravity on Single Human Cells	•			CM	•			24			•				
SO71	Circadian Rhythm of Pocket Mice		•		CSM	•				48						
SO72	Circadian Rhythm of Vinegar Gnats		•		CSM	•										

Experiments M551 through M555 are included.

Assignment of experiment equipment to specific areas in the Skylab orbital configuration is primarily influenced by the degree of crew participation and the functional support capabilities required in terms of available weight and volume capacity, electrical power accessibility, viewing orientation, etc. Figure 4-1 depicts this assignment.

Galactic X-Ray Mapping and Thermal Control Coatings Located on IU



1. Circadian Rhythm (Pocket Mice)
   Circadian Rhythm (Vinegar Gnats)
2. UV Coronal Spectroheliograph
   White Light Coronagraph
   UV Spectrometer
   X-Ray Spectrographic Telescope
   UV Spectroheliometer
   X-Ray Telescope
   UV Spectrograph
3. Gegenshein Zodiacal Light
   Foot Controlled Maneuvering Unit
   UV Stellar Astronomy
   UV Panorama
   Crew Vehicle Disturbances
   ATM Contamination Measurement
   Coronagraph Contamination Measurement
   Astronaut Maneuvering Equipment
   X-Ray Solar Photography
   Airglow Horizon Photography
   Particle Collection
4. Human Vestibular Function
   Mineral Balance/Bioassay of Body Fluids
   Metabolic Activity
   Aerosol Analysis
   Body Mass Measurement
   Time and Motion Study
   Specimen Mass Measurement
   Vectorcardiogram
   Sleep Monitoring
   Habitability Crew Quarters
   Lower Body Negative Pressure
   Blood Studies
5. Thermal Control Coatings
   Manual Navigation Sighting
6. Materials Processing in Space
   Nuclear Emulsion
   Earth Resources Experiments
   O–F Flammability
7. Radiation in Spacecraft
   Effect of Zero g on Human Cells

Figure 4-1. Skylab Experiment/Location

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